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INDUCTANCE OF LINES.

Elsewhere in this issue Mr. G. M. Warner discusses inductance drop, which is a matter of increasing importance in connection with alternating conductors. Kennelly has treated this subject thoroughly in a paper read before the American Institute of Electrical Engineers and in an article in our columns last week, but the practical examples worked out by Mr. Warner will be found of much assistance in getting a good grasp of the principles. It will be noted that stress is laid upon the necessity of taking into consideration phase differences in E. M. F., caused by capacity or by motor loads. The ordinary tables of inductance co-efficients are based upon non-inductive loads, and therefore may lead to considerable errors in calculation if applied to lines whose capacity cannot be neglected or which carry current for motors whose inductance throws the current and E. M. F. out of phase.

PERMEABILITY OF STEEL.

Some months ago Mr. H. F. Parshall pointed out in a paper read before the Franklin Institute, an abstract of which appeared in our columns, the great variations in the permeability of steel resulting from the presence of different proportions of carbon and manganese, and of impurities like sulphur, phosphorus and silicon. We print elsewhere an article by Messrs. Osterberg and Munroe containing the result of careful experiments made by them at Columbia College on two different steels, which, in connection with the chemical analyses given, forms another useful contribution to the subject, and strongly confirms the experiments of Mr. Parshall. The conclusions arrived at are of much importance, and besides pointing out the absurdity of basing calculations on conventional permeability curves, they imply that for even the most ordinary commercial work permeability tests of the magnetic material to be used should be made, or, at least, a chemical analysis furnished from which to judge of its magnetic quality. It would be very useful if chemical analyses were made, where possible, of iron or steel subjected to permeability tests, for by so doing it is very probable that the effect of different limiting proportions of carbon and other elements would be finally so definitely determined that the magnetic quality of a material could be approximately determined from a chemical analysis alone.

DOES ELECTRICITY KILL?

In the Digest will be found an abstract of a paper recently presented by Dr. D'Arsonval to the French Academy of Sciences on resuscitation after electric shocks. As D'Arsonval is one of the very greatest living authorities on electro-physiology, his conclusion that in case of electric shock unaccompanied by lesions the subject can be resuscitated by means of artificial respiration is of the utmost importance. Still more startling is his assertion that electrocution, as practiced in this country, does not cause actual death, but merely produces asphyxiation and syncope, from which the criminal may be revived. The latter statement, coming from such a source, cannot be passed over lightly, and should cause the New York State authorities to make the necessary test on the next criminal electrocuted. The case he adduces to support his statement is a remarkable one, for the man who was resuscitated was subjected to an alternating voltage of 4,500 for some minutes, with, it would seem from the description, a contact that could not during the entire time have been of any relatively considerable resistance. It is seven years since Dr. D'Arsonval, from laboratory experiments, formed his conclusions in regard to the effect of electric shocks, and the confirmation received through the case just noted seems to be most complete, and, therefore, his system of treatment is one with which every person engaged in electrical pursuits should be familiar.

D'Arsonval gives the practical formula, *A man shocked by electricity should be treated as if drowned.* In addition to the well-known methods for the resuscitation of the drowned, he recommends the electrical excitation of the laryngeal nerves or rhymthic traction of the tongue. While in a given case D'Arsonval finds that real death may occur from the lesion or destruction of tissues by disruptive or electrolytic effects of a current, these, he adds, seldom occur with the alternating current, and may not follow a shock from a continuous current. As a consequence, every electrician should be prepared in case of an accident to apply the necessary treatment, and to this end should make himself familiar, if not already so, with the method of resuscitating the drowned. Regardless of what the future might show, the actual evidence is now sufficient, aside from the great authority of D'Arsonval, to render it a duty for the electrician to be thus equipped for the saving of human life.

GAS ENGINES FOR ELECTRIC LIGHTING.

In Europe gas engines are much employed in isolated electric lighting, and in several central stations on the Continent they furnish the entire motive power. At Dessau, Germany, for example, the power plant consists of two gas engines of 120 h. p. and 60 h. p. respectively, which charge accumulators of 1,700 ampere-hours' capacity, the annual output being 49,869 kw.-hours. Mr. E. C. Segundo, in the London *Electrical Review*, has recently given some calculations as to the cost of generating current with gas engines, both in private and central station lighting plants, which are rather favorable and show at least that the matter is well worth looking into, particularly in connection with isolated and accumulator station plants. It is stated that a certain English manufacturer will guarantee his gas engines of large power to generate a brake horse power on 18 cubic feet of coal gas per hour, and with an 80 per cent. electrical efficiency this gives 13,200 candle-hours, as against 3,200 if the gas were burned in jets—a ratio of 4.125. Using Dowson gas, the same manufacturer states that his engines will develop one brake horse power on one pound of anthracite coal. We doubt if there is any steam engine now used in electric lighting that will develop a horse power on less than two pounds of coal, so that the saving is here very pronounced, so far as fuel consumption is concerned. With a smaller plant it would be a pretty poor gas engine that would require a consumption greater than 40 cubic feet of gas to the brake horse power. With gas at $1.25, 3-watt lamps, and an electrical efficiency of 80 per cent., this would bring the cost of a 16-c. p. incandescent lamp to 5-12 cent per hour, exclusive of labor and incidentals, while the cost of a 16-c. p. jet, using five cubic feet of gas per hour, would be 5-8 cents. The saving here is 33⅓ per cent. over burning gas direct, which in a 150-light plant would amount to 31 cents per hour, against which should be charged the cost of water and labor; with a gas engine using 25 cubic feet per h. p. per hour this saving becomes 50 cents. As most establishments that would require 150 lights would have some one about the premises who could look out for the electrical plant with little or no extra expense, and as gas engine electrical plants take up but little room and do not require constant attention, their use for isolated plants presents an advantage aside from the immense superiority of the incandescent light over gas light.

THEORY.

One of the most abused of words is "theory," not only from being made the object of the sneers of the "practical man" and the worshipper of "horse sense," but even more so from its misapplication to designate the wildest speculations and the most absurd fancies. It is singular, but none the less true, that those who most inveigh against theory and theorists are the very ones who have brought the words into disrepute. Given a half-educated man, and therefore possessed of that little knowledge which is dangerous, or an uneducated man, but who is considered "bright" and "brainy" in a narrow community or by an uncultured circle of acquaintances, and we have in either case a theorist in the sense in which the word is condemned, and one, who, with the slightest encouragement, will glibly reel off by the yard what he supposes to be theory, and which his hearers accept as such. We constantly receive smartly written or ungrammatical manuscripts giving the "true theory" of electricity, of magnetism, of the causes of various electrical phenomena, and we do not remember a single one of these which ever contained a real experimental fact upon which to rest the conclusions arrived at. In looking over our newspaper exchanges, particularly those containing an electrical column—that medium for the dissemination of so much electrical misinformation—we can find in a year more theories in number than have been fathered by scientists in a century. We have before us now, in a clipping, a typical example of this class of productions, in which the writer demonstrates to his satisfaction that the rotation of the earth on its axis is due to electrical action. In a manner very characteristic of his type, who invariably treat the theories of others with the loftiest disdain, regardless of their authority, he disposes of the accepted scientific opinions as to the cause of the earth's rotation with the statements that they are "the silliest nonsense, not worthy of a "serious thought," which "might do for monkeys, but should find "no place in the minds of men." "Let reason have a chance and "electricity a hearing," he demands, and then, after describing how a shaft with radial arms may be given motion by the action of static discharges from points on these arms and at right angles to them, he proceeds to develop his theory as follows: "The earth is a "spherical rotating magnet, the electricity coming to it at its north "and south poles, meeting at and going off into space over its equa-"tor. These electrical currents move in spirals. Imagine yourself "off and facing the north magnetic pole of the earth. With your "pencil begin at the pole and make circles to the right, with the "sun, as you face the latter, and each circle nearer the equator. "Not a complete circle, but a continuous line called a spiral. The "electricity coming from space moves with that system of circles "which is called right-handed spirals. Now face the south pole of "a terrestrial globe, or imagine yourself off and facing the south "pole of the earth, and this time draw a left-handed spiral. Begin "at the south magnetic pole and circle from right to left, with the "sun, as you face it, never lifting the pencil, each circle nearing "the earth's equator, and you will have the left-handed spiral, "the movement of the electrical current in the earth's surface as it "comes from space and nears the earth's equator from the south "pole. You will readily see that both north and south of the "earth's equator, the electrical currents, as explained above, would "move from east to west, and this is in accord with the magnetic "records in the geodetic surveys. It will further be readily observed "that the currents coming from the north and south poles of the "earth are moving toward sunset, while the earth revolves toward "sunrise, and if they go off into space they act upon the earth as "explained in reference to the wheel, and the impact on the earth "would cause the latter to rotate eastward." The complacent manner in which utterly false premises are laid down will be noticed, and also the seductive flattery to the reader in the remarks as to how "readily he can see" an impossibility. From sad experience, however, we can add that such benignity may also be united with rancor, and the editor who declines such manuscripts informed that if he had an iota of brains or the slightest knowledge of the science he wouldn't make an ass of himself by denying what any fool could see must be true.

Nomenclature.

Our esteemed contemporary, the London "Electrician," has generally been opposed to burdening any science with new and unintelligible terms which have to be learned, but it seems to have changed its opinion lately, as we find in a recent editorial that the comparatively simple and inoffensive term "Congo red" is referred to as "amidosulphonaphthaleneazodiphenylazonaphthylamine sulphonic acid."

Improving the Human Eye.

"It is just conceivable that at some distant date, say by dint of inserting gold wires or powder in the retina, we may be enabled to see waves which at present we are blind to."—Prof. Oliver Lodge.

Charles Proteus Steinmetz.

Few indeed of those who have followed the advances of modern electricity are not more or less familiar with the important contributions of Mr. Charles Proteus Steinmetz, both to the theory and practice of electrical engineering, and there are few, even among those who had not had the pleasure of personal acquaintance with him, who will not be glad to know something of a more than usually interesting and useful life.

Charles Proteus Steinmetz was born in the city of Breslau, in Southeastern Germany, in the month of April, 1865. After passing through the gymnasium (high school) in his native city, he entered the University of Breslau, and devoted himself especially to the subject of mathematics, which he has put, in later years, to such splendid use. In particular he was a pupil of Prof. Schroeter, then the greatest living authority in synthetical geometry, and Prof. Galle, the great astronomer, who is universally known as the discoverer of the planet Neptune.

After leaving the university, Mr. Steinmetz, having no special inclination for the professions, determined to devote himself to his favorite sciences, and rendering himself independent by becoming an instructor in mathematics, he took up the study in Breslau, and afterwards in Berlin, of various branches of physical science, while not neglecting the study of pure mathematics to which he at first gave his attention. He worked in the physical laboratory with especial success, and undertook an investigation on the secular variation of terrestrial magnetism, unfortunately never finished. Of course, anent his investigations, he has divers amusing reminiscences, particularly on one occasion when, with the help of some friends, he made, with the temperature far below zero, magnetometer readings on the ice of the frozen river Oder, to escape local magnetic disturbances. After a little, his less enthusiastic friends went away "for a few minutes to warm themselves," and after an hour's patient work, Mr. Steinmetz determined to find out what had become of them, and they were finally discovered in a comfortable room playing skat, and waiting for him to finish his observations, which he says eventually proved to be useless because he had forgotten to take off his steel-rimmed eye-glasses.

CHARLES PROTEUS STEINMETZ.

During this period, too, Mr. Steinmetz worked industriously in the chemical laboratory, and paid attention to mineralogy and other natural sciences, including a casual study of medicine.

At that time, all young Germany was intensely interested in the great problems of national economy which have been coming to the front in the last quarter of a century. Mr. Steinmetz, ever enthusiastic, and with high ideals of ethics in government, became imbued with revolutionary ideas, and even edited for a time a somewhat revolutionary paper which came to an untimely end for lack of the "sinews of war." After what was left of the paper had been confiscated by the government, the editor drifted to Austria, and later to Switzerland, and there entered the Polytechnical School at Zurich, and took up the study of mechanical engineering. He then made a short visit to France, and thence in 1889 came to America, where he settled down to apply the knowledge which he had acquired through so long and active a period of student life.

He first connected himself with the Eickemeyer Company, in Yonkers, N. Y., and remained there four years, filling the period with scientific investigations of rare value, in which he says, with characteristic modesty, that he was greatly assisted by the personal cooperation of Mr. Eickemeyer. At the end of this time, he left with regret his first American home in Yonkers, and joined the forces of the General Electric Company, at Lynn, Mass.

Mr. Steinmetz's writings have been of a very varied and interesting character, as might be imagined from the wide range of his studies. Much of his work has been in pure mathematics, and is consequently less known to the electrical fraternity than some of his later researches. Among his various works may be mentioned a popular hand-book of astronomy, published in Germany in 1888, and various articles to the "Theory of Synthetical Geometry;" "On Twisted Curves," contributed to the American Journal of Mathematics, and divers researches on pure mathematics, contributed to the "Zeitschrift fur Mathematic und Physik."

Most of Mr. Steinmetz's electrical work has been published since his arrival in this country, so that we may be proud to reckon him as being, to all intents and purposes, an American electrician, as he surely is in spirit.

As to his most important electrical researches, we mention "The Theory of the Alternate Current Transformer," three elaborate and valuable papers on "The law of Hysteresis," comprising the results of nearly two years of careful investigation, and presented to the American Institute of Electrical Engineers; a paper on the "Disruptive Strength of Dielectrics," and a large number of minor papers on dielectric hysteresis, inductance and kindred subjects.

Perhaps the most important of all his contributions to literature was a very complete and beautiful study of the application of the vetor analysis as expressed in complex quantities to problems of alternating current work. This was read before the International Electrical Congress in Chicago, 1893, and has since been expanded into a formal treatise on the subject, which will soon be published.

As a practical electrician Mr. Steinmetz is a most expert and intelligent designer of both direct and alternating current machinery, and is well equipped and ready for the solution of every sort of problem which comes before the modern electrical engineer. It may be truly said of him that he has not an enemy in the world, and that every one who is brought into personal communication with him feels toward him the strongest feelings of friendliness—even those who have suffered at his hands in debate; at which, as the members of the American Institute of Electrical Engineers well know, he is most expert. Much as all those who have read his papers respect him by reason of his ability, still more do those who have known him admire the gentle and kindly spirit of the man.

Meeting of the Union of German Electricians.

(From our special Correspondent.)

The second annual general meeting of the Verband Deutscher Elektrotechniker, or Union of German Electricians, took place at Leipzig between the 7th and 9th of June.

The meeting was formally opened on June 8 by Baurath Stübben, of Cologne. After several addresses of welcome had been read in the name of the city of Leipzig and its technical societies, the electrical exhibition that had been formed in connection with the occasion was opened by the honorary president, Privy Councillor Prof. Dr. G. Wiedemann. A round of inspection was then made of the exhibition. The rest of the day was devoted to a dinner, attended by all the delegates to the meeting, and to the reading of papers. On Saturday, June 9, the business discussions came on, under the presidency of Prof. Dr. Slaby. The proceedings began with the presentation by the secretary, Herr Sluzewski, of the general report for the past year and the estimate of expenditures for the year 1894-95. This was followed by discussion of the new regulations. The organization is to be known henceforth as the "Verband Deutscher Elektrotechniker," with headquarters in Berlin, and its business to be conducted by a secretary general, to which office Mr. Gisbert Kapp, so well known in the electrical field, was elected. Several papers were then read, one of the most interesting of which was by Prof. Dr. Budde, on the influence of electric tramway currents on institutes for physical research. Prof. Kohlrausch and Prof. Wiedemann engaged in the discussion which followed. All were of opinion that these institutes should be subordinate to the requirements of traffic, and that if it was necessary for the carrying on of scientific investigations to have the surroundings absolutely quiet and uninfluenced by extraneous currents, such establishments should be situated away from the town.

A report was also read by Prof. Dr. Budde on the position to be taken by the union in respect to the proposed industrial exhibition in Berlin in 1896. Dr. Budde urged that they should abide by the

decision come to at the Cologne meeting last year, viz.: That light and power should only be supplied against payment, a syndicate being formed for the purpose amongst the members of the union, under the direction of a special committee, in order to secure fair terms and division of the work. Similar action was proposed with regard to the forthcoming exhibition at Karlsruhe.

The exhibition in connection with the meeting at Leipzig, to which reference has been made above, contained nothing specially new. Small types of dynamos and motors were shown, mostly by local firms. The motors were applied to workshop tools, pumps, printing presses, etc. They were all of the two-pole type, rather large in relation to their capacity, and ran at very high speeds, so that countershafting was employed in every case. Messrs. Siemens & Halske had some small dynamos, which, however, were not in operation. There was one novelty in the shape of an instrument for testing different qualities of iron, constructed by Dr. Kupsel and described some little time ago in the Electrotechnische Zeitschrift. The Allgemeine Elektricitaets-Gesellschaft, of Berlin, had installed two induction motors and a stationary transformer, but these were not in operation either. Their exhibit included further an electric meter, with pendulum and automatic winding arrangement, an invention of Hefner-Alteneck. The apparatus was shown at the World's Fair. Several types of the well-known Aron meter were also on view. Mention should be made of an 8-h. p. horizontal steam engine by Ducommun, of Mulhouse, Alsace-Lorraine, which made 400 revolutions per minute and ran very quietly, although its regulation under varying load was slow, owing to throttling.

The next general meeting of the Union of German Electricians will be held at Munich in 1895.

Berlin, June 16, 1894.

Laboratory Notes.—XIX.

BY LIEUT. F. JARVIS PATTEN.

AN EXPERIMENT THAT FAILED.

Many experiments, and sometimes mere trials of plans that on the surface appear to be not only good, but practical, inventions, fail to give the results expected, and prove a source of vexation and disappointment to the person who gives time and money to the investigation. I have known quite a number of such cases of rather unusual interest, some of my own contrivance and some that others have gained dearly-paid experience from and then invited me to tell them why their scheme would not work. It would be really a good thing if all such experiments, however unsuccessful, were described. Many an inventor and experimenter would be saved both disappointment and expense could he be shown that there was no reasonable expectation of success in a work he was about to undertake, or that the scheme had been tried on the intended, and had failed.

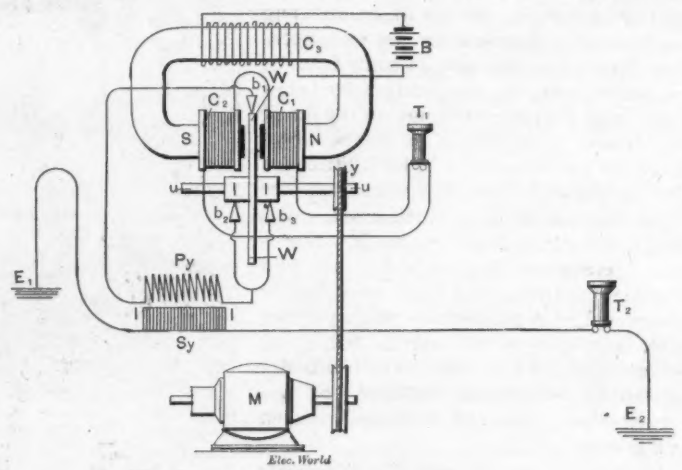
The experiment described here is selected from a number of interesting cases that I have witnessed, and I consider it interesting because I cannot give a reason entirely satisfactory to myself why the plan should not work. Yet it was carefully tried with many modifications, and all without encouraging results.

Though the object in view—namely, to make a "telephone repeater"—was a rather ambitious one, the particular plan upon which it was attempted to solve the problem, as well as the underlying principles of the solution, were comparatively simple, and seem almost certainly operative on paper. The general plan was simply this: A telephone transmitter, no matter what the form, so far as this description is concerned, generates a current that goes to line. It is, of course, a very weak current, but there is some, and sensitive apparatus like a telephone receiver (Bell magneto) is variably magnetized by such a current, and its energy is retransformed to mechanical energy in the moving diaphragm and given to the ear as waves of sound. The energy of the current must, however, produce magnetism to do this, and in producing magnetism it certainly creates a magnetic field, varying in strength directly as the current. It produces then an alternating magnetic field, and an armature revolved in such a field should generate an alternating current having an impressed electromotive force that follows in period or rate, and intensity or amplitude the fluctuations of the field magnetism produced, say, by the current from a distant telephone transmitter to which words were spoken. That is to say, it was designed to use a telephone current as a separate excitation of the field of a very small dynamo, the armature of which was to be driven by independent power in the usual way.

Such an armature should yield an alternating current similar to the telephone current, but of greatly increased intensity, because we have a new source of power.

It would be a very inefficient dynamo on which 15 per cent. to 20 per cent. of its entire output were used for field excitation. In this case the telephone current is used; the separate field-exciting current of the dynamo and the armature is driven by independent power external to the system. We should, therefore, expect an armature current of far greater strength than the original telephone current. In other words, the armature should reproduce the telephone current accurately, so far as its fluctuations are concerned, but of far greater intensity. We should, therefore, have in such a machine a telephone current amplifier or multiplier, as well as a mere repeater, and if this were found true for one machine, the new current could be used to excite the field of another, and so on until the current were increased to any desired limit. Evidently this could not, however, be carried very far, as there is undoubtedly a tendency in such continued transformations to bring the alternating current wave to a pure sine form, which would eventually destroy the delicate superimposed fluctuations of the telephone current.

The general plan is shown by a diagram (Fig. 1), which gives the operative parts and circuits. T_1 is a telephone transmitter. Its line goes to the field coils, C_1, C_2, of the field magnet, N S, the air gap between the poles of which was less than an eighth of an inch. The coils, C_1, C_2, were ordinary telephone coils, their resistance in series being about 80 ohms of No. 32 magnetism, or about the same as a telephone receiver. The field magnet, N S, was a round bundle of very soft annealed iron wire, the entire magnetic circuit being about six or seven inches long. A battery, B, with its circuit, C_3, coiled about the yoke of this magnet, was used with a variable resistance to give the field, N S, a sufficient degree of magnetization to bring the iron to the point of maximum



Telephone Repeater.

permeability—where it would, in fact, be most susceptible to very slight changes of field currents, such as those received from the telephone transmitter. In the field, N S, was placed an armature consisting simply of a thin disc of silver, with brushes bearing at the periphery, b_1, and at the spindle, b_2, b_3, thus completing a very small and simple form of unipolar dynamo of the Barlow wheel or Faraday disc type. This armature could be driven at any desired speed up to 12,000 revolutions a minute by an electric motor, M.

Of course, the voltage given by such an armature, having practically but a single turn of wire, would be exceedingly low, no matter what the speed or the field excitation. But as it revolves in a variable or alternating field, it must necessarily yield an alternating current, and, therefore, by connecting a circuit from its brushes to the primary, Py, of a transformer or induction coil, the voltage could be raised to any desired value in a secondary, Sy, which latter circuit was connected to a line with a telephone receiver, T_2, at the distant end. It may be well to explain why a unipolar machine was first selected for this experiment, instead of some other direct current type of drum or ring armature capable of generating a higher voltage.

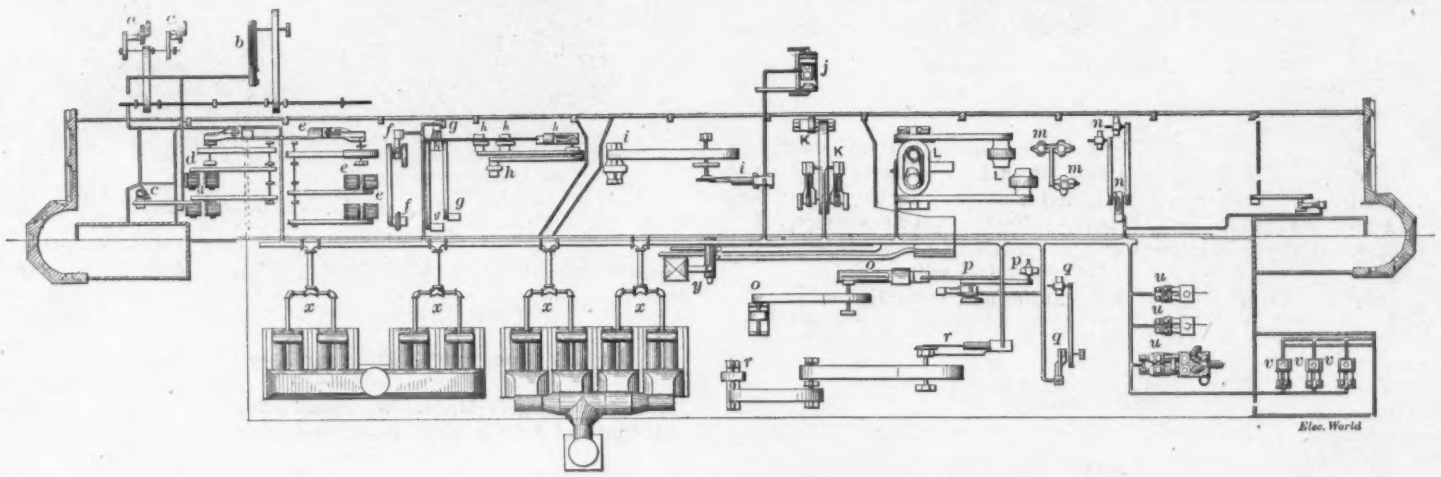
The reason is that most any such armature, having a commutator, must necessarily produce a fluctuating current—as, for instance, when the brushes of such an armature bear on two consecutive commutator segments, two coils of the winding (meaning many turns) are cut out of circuit, and when they are each on a single segment these coils are in circuit again. This changing resistance causes all such armatures to yield a fluctuating current, which would destroy the delicate fluctuations of the telephonic current. The unipolar, or disc machine, on the contrary, yields at a constant

speed a perfectly smooth and uniform current as long as the field is constant, and if this is altered the current in the armature must follow the fluctuations of the field. The disc machine as described, which was probably the smallest unipolar machine ever built, was tried under a great variety of conditions, but without encouraging results, and I am at a loss to say definitely what the trouble was. The machine generated current, but the telephone in the secondary circuit of the induction coil, I, gave no response.

A Gramme ring armature that gave a perfectly smooth current, without fluctuations of any kind, was then devised, built and substituted for the disc. Its construction, being novel, deserves description. A soft iron wire ring (core of the armature) was encased in fibre, and in a miller, 240 slots, large enough to take a No. 18 wire, were cut on both the inner and outer periphery. The core was then covered with a single layer of 240 turns of bare copper wire, each turn being thus air spaced from its neighbor, and the brushes were arranged to run on the bare wire. Thus, each single urn of wire was its own commutator segment, and the amount of wire cut in and out as the brushes would bear first on one and then on two turns would only be the half of a single turn, but the brushes were made so as to extend over three or more turns, so that there was always the same amount of wire in the armature circuit, and a current free from any fluctuations could be obtained; and this was proven by the failure of the telephone to give any sound when connected in the armature circuit. The results were not more promising with this armature than with the disc pattern.

The Power Plant of the Midwinter Fair.

We present herewith a plan of the power plant of the California Midwinter Exposition, from which the arrangement of the machinery will be apparent. The original plan was to have all the engines in line parallel to the boilers and as near the back walls of the building as possible, all belts running parallel and the dynamos placed in line under the break of the gallery. The miners' exhibit, however, was allotted space which interfered with this and necessitated a change in the plans. Furthermore, the dynamos are all operative exhibits, and it was desirable to concentrate the displays of the various companies as far as possible. Considering the number of belts necessary, it would perhaps appear that it might be difficult to move about in the plant, but the arrangement is such that any point can easily be reached.



PLAN OF POWER PLANT OF THE MIDWINTER FAIR.

Inductance of Lines.

BY G. M. WARNER.

Having repeatedly found occasion in the calculating of lines for alternating current power transmission to use the inductance of one wire on the other, which as we know appears as a loss of voltage by increase in the apparent resistance of the line, and never finding a table embodying just what I wanted, I calculated some time ago an extra column to my wire table.

The formula used is one which can readily be found in text books:

$$L = .5 + 2 \log \frac{d}{r}$$

where d is the distance between the wires and r is the radius of the wire, both being expressed in the same units, and L is the coefficient of self-induction per centimetre of wire, expressed in centimetres. Hence, for the table where I have used millihenrys per mile, the formula becomes:

$$.1609 \left(.5 + 2 \log \frac{d}{r} \right)$$

Size of wire. B. & S.	Resistance per mile. 15.5° C.	Inductance in millihenrys per mile for d = 8″	12″	16″	20″	24″
0000	.259	1.22	1.35	1.44	1.52	1.57
000	.324	1.26	1.39	1.48	1.56	1.61
00	.412	1.30	1.43	1.52	1.59	1.64
0	.519	1.34	1.47	1.56	1.63	1.68
1	.655	1.37	1.50	1.60	1.67	1.72
2	.826	1.41	1.54	1.63	1.71	1.76
3	1.041	1.45	1.58	1.67	1.74	1.79
4	1.313	1.49	1.61	1.71	1.78	1.83
5	1.656	1.52	1.65	1.75	1.82	1.87
6	2.088	1.56	1.68	1.78	1.85	1.91
7	2.633	1.60	1.72	1.82	1.89	1.94
8	3.320	1.63	1.76	1.86	1.93	1.98
9	4.186	1.67	1.80	1.90	1.97	2.02
10	5.280	1.71	1.83	1.93	2.00	2.06

Tables have been published giving impedance factors of wires at various distances and cycles, and perhaps a few examples of the difference between these tables and the above will be of interest.

I will take a case where we have a line, say one mile long, with 1,000 volts and 50 amperes at the receiving end, and work out the voltage required at the generator under various conditions, supposing the line to be of No. 3 B. & S. wire and 12″ apart, using 125 cycles per second.

No. 3 wire has a resistance of 1.04 ohms per mile, and, from the table, an inductance of 1.57 m. p. per mile at 12″ apart.

The resistance drop for the two miles of wire is $50 \times 2 \times 1.04$ volts, and the inductance drop equals $2 \pi n L C 10^{-3} = 2 \times 3.14 \times 125 \times 1.57 \times 10^{-3} \times 2 \times 50 = 107.5$ volts, but is not in phase with the resistance drop, differing by 90 degrees; compounded by the law of resultant forces, the total drop would be

$$\sqrt{\overline{104}^2 + \overline{107.5}^2} = 149.5 \text{ volts, or } 74.8 \text{ volts per wire.}$$

From a table of impedance factors we would obtain for these same conditions 1.44, giving as the drop $1.04 \times 1.44 = 149.5$, the same as before; but what I wish to show is that, while this drop does actually occur, it may not necessarily be in phase with the line potential, and hence will not appear as a loss of voltage—that is, the difference between the voltage of the dynamo and that received at the end of the line may be less than this drop of 149.5 volts.

First, we will assume that we are feeding a non-inductive load. Here the C R of the load = 1,000 volts, and the total $C R = 1{,}000 + 104 = 1104$; the inductive drop of the load = 0, and of the line = 107.5; hence the total inductive drop = 107.5 + 0 = 107.5. Combining these by the same method as before gives as the generator potential:

$$\sqrt{\overline{1104}^2 + \overline{107.5}^2} = 1{,}110.$$

We see in this case that the actual loss in voltage in the transmission is 1,110 — 1,000 = 110, or 39.5 less than the drop simply due to the lack of agreement in phase.

We will take another case where the load is inductive, causing a lag of 46°—that is, its inductive component is 120 volts and its

energy component 696 volts, giving the total voltage of the load still:

$$\sqrt{\frac{2}{720} + \frac{2}{696}} = 1{,}000.$$

Then our total C R drop is 696 + 104 = 800 volts, and the total inductive drop = 720 + 107.5 = 827.5, and the generator voltage equals

$$\sqrt{\frac{2}{827.5} + \frac{2}{800}} = 1{,}150,$$

giving a loss in voltage of 1,150 — 1,000 = 150, or the same as given by the impedance factors.

Suppose we feed a condenser load having an advance of 46°—that is, an energy component of 696 volts and a wattless component of 720 volts, giving as a resultant:

$$\sqrt{\frac{2}{696} + (-720)^2} = 1{,}000.$$

Then our total C R drop is 696 + 104 = 800, and the total wattless drop = 720 = — 107.5 = — 612.5, and the resultant E. M. F. at the generator

$$= \sqrt{\frac{2}{800} + (-612.5)^2} = 1{,}075,$$

giving a loss of voltage of only 75 volts.

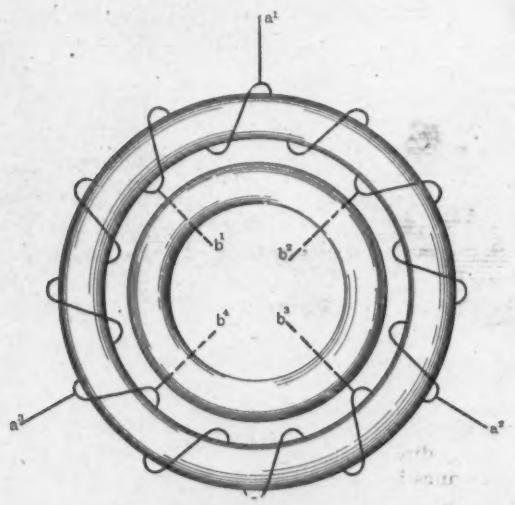
In fact, it is often the case that the E. M. F. at the generator is less than that at the end of the line. The above examples, I think, illustrate the method of calculating lines, which, in a few words, consists of resolving all the various E. M. Fs. and currents into their two components—one the energy and the other the wattless component—and finally combining the sums of these two components by the law of resultant forces. No account is here taken of the extra resistance due to the "skin" effect, for it is usually very slight.

Polyphased Transformation.

To the Editor of the Electrical World:

Recent articles in The Electrical World on the transformation of currents of one phase into currents of another phase have been particularly interesting to me as I had been working on this problem just previous to their publication. Believing that a description of my device may prove of interest at this time, I send the accompanying sketch, which, I think, will nearly explain itself.

Strictly speaking, this is not a transformer, but rather a "translating device," as the current is changed in phase only and there is



Polyphased Transformation.

but one winding on the cores. I take the ordinary ring cores and wind one of them with a single coil, the other core serving to complete the magnetic circuit.

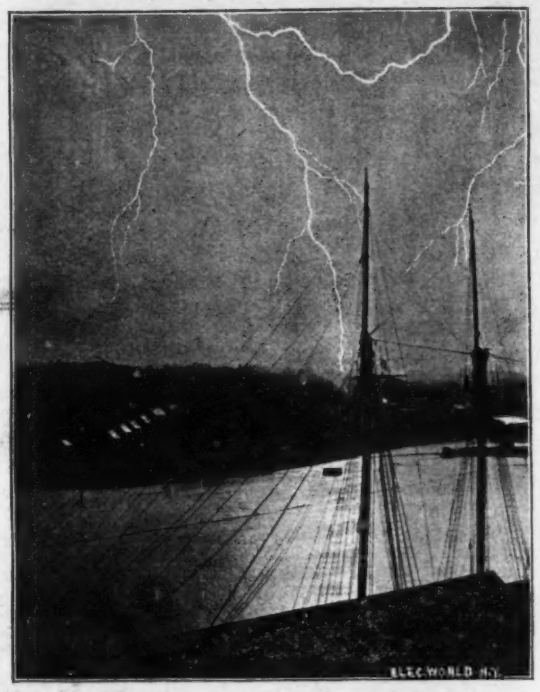
As an example, take a case where a three-phased current is to be converted to one of four phases; the rotary field is produced by the three-phased current connected to the terminals a^1, a^2, a^3, and the four phased current can then be drawn off from the same wire as at terminals b^1, b^2, b^3, b^4.

It is quite evident that with this device currents of any phase whatever can be changed to any other phase.

Johnstown, Pa. BRUCE FORD.

Photographing a Lightning Bolt.

The accompanying illustration is taken from a photograph made by an amateur, Mr. W. B. Getchell, of Augusta, Me., during an electrical storm in that vicinity. The bolt seemed to go across the heavens in an irregular line, until reaching a point at about the center of the top of the illustration, when it took an almost perpendicular course to the earth, where it struck at a point about a quarter of a mile distant. The white dots in the background are the arc lights on the opposite side of the river. At the time of the



Photograph of Lightning Flash.

exposure everything was in darkness, and the whole illumination came from the lightning flash.

Moonlight Tables for August, 1894.

Herewith we give Mr. H. W. Frund's tables of lighting hours for the month of August under his modified form of moonlight schedule.

	TABLE NO. 1. Standard Moonlight System.			TABLE NO. 2. Frund's New Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.40 P. M.	2	4.00 A. M.	1	7.40 P. M.	2	4.00 A. M.
2	7.40 "	3	4.00 "	2	7.40 "	3	4.00 "
3	7.40 "	4	4.00 "	3	7.40 "	4	4.00 "
4	7.40 "	5	4.00 "	4	7.40 "	5	4.00 "
5	7.40 "	6	4.00 "	5	7.40 "	6	4.00 "
6	9.00 "	7	4.00 "	6	7.40 "	7	4.00 "
7	9.20 "	8	4.00 "	7	7.40 "	8	4.00 "
8	9.50 "	9	4.00 "	8	7.40 "	9	4.00 "
9	10.30 "	10	4.10 "	9	7.30 "	10	4.10 "
10	11.10 "	11	4.10 "	10	7.30 "	11	4.10 "
11	12.00 M.	12	4.10 "	11	7.30 "	12	4.10 "
12				12	7.30 "	12	M.
13	1.00 A. M.	13	4.10 A. M.	13	7.30 "	13	"
14	2.00 "	14	4.10 "	14	7.30 "	14	"
15	No light.	15	No light.	15	7.30 "	15	"
16	"	16	"	16	7.30 "	16	"
17	7.20 P. M.	17	8.40 P. M.	17	7.20 "	17	"
18	7.20 "	18	9.00 "	18	7.20 "	18	"
19	7.20 "	19	9.20 "	19	7.20 "	19	"
20	7.20 "	20	9.40 "	20	7.20 "	20	"
21	7.20 "	21	10.00 "	21	7.20 "	21	"
22	7.20 "	22	10.30 "	22	7.20 "	22	"
23	7.20 "	23	11.10 "	23	7.20 "	23	"
24	7.10 "	24	12.00 M.	24	7.10 "	24	"
25	7.10 "	26	12.50 A. M.	25	7.10 "	26	1.00 A. M.
26	7.10 "	27	2.10 "	26	7.10 "	27	1.50 "
27	7.10 "	28	3.20 "	27	7.10 "	28	3.20 "
28	7.10 "	29	4.20 "	28	7.10 "	29	4.20 "
29	7.10 "	30	4.30 "	29	7.10 "	30	4.30 "
30	7.10 "	31	4.30 "	30	7.10 "	31	"
31	7.00 "	1	4.30 "	31	7.00 "	1	"

Total No. of hours, 162.00.

Note.—These schedules are made up on sun time. Where standard time is used, and it varies considerably from sun time, the proper deduction or addition must be made to all the times here given.

Central Lighting and Power Stations of Chicago.

BY CHARLES DESMOND.

Chicago is about as well supplied with electric light and power as any city in the United States, a great part of which is furnished from central stations, the largest and most numerous of which are owned and operated by the Chicago Edison Company, which has six separate and distinct stations located in different parts of the city. One of these stations has an annex which contains machinery with a capacity of 600 kilowatts, and another station now being built is to be fitted with the latest improved machines with a total capacity of 8,000 kilowatts.

The Chicago Edison Company commenced business in 1886 with a small station located in a basement and having but small capacity. The service given and the rapidly increasing demand for light soon compelled it to seek larger quarters and install more capacious machines. The station on Adams street, which is now known as Station No. 1, was then erected and equipped with the best machines for the purpose which could be procured.

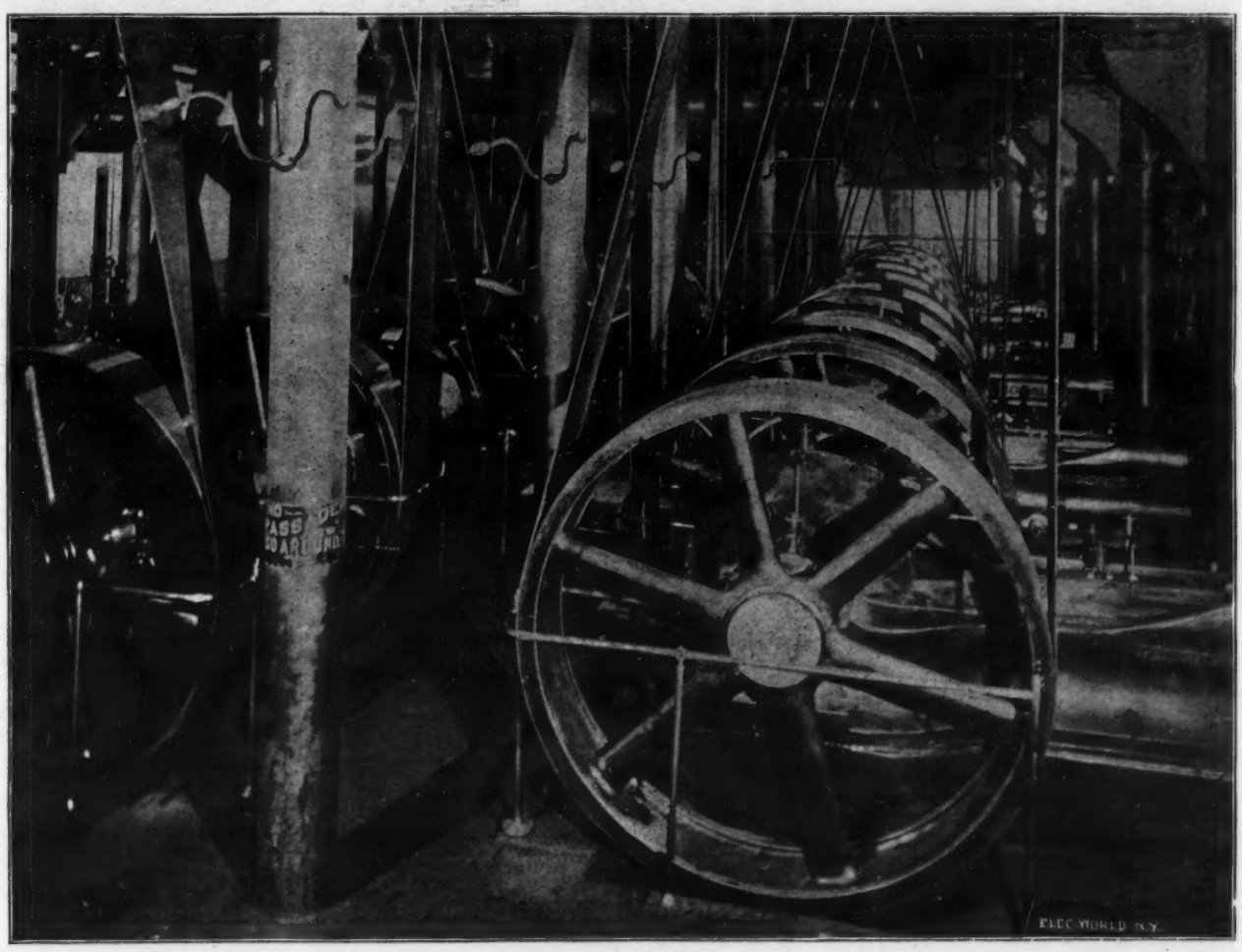
The following named gentlemen are the present officers of the company: Samuel Insull, president; F. S. Gorton, secretary and treasurer; G. H. Wilmerding, general superintendent; W. H. Anthony, comptroller; W. L. Church, superintendent of low tension, and P. L. Kelsch, superintendent of high tension systems; L. A. Furgeson, electrical engineer; R. W. Francis, chief engineer.

Station No. 1 was erected in 1888 near the centre of the business district, and was designed not only for the amount of business that was apparent at the time, but with a knowledge that it would increase considerably, and calculations were made accordingly. The style of the building is ornamental, having an arched front, supported by Corinthian columns, and is built of red, pressed brick, three stories high, with a capacious basement. The frontage is 44 feet, with a depth of 200 feet. The front portion, which contains the offices, store room and testing room, is 26 feet in depth. Back of the offices, on the ground floor, is the engine room, 100 by 44 feet, in which is very compactly installed 16 high-speed engines, consisting of eight Armington & Sims, four of which are 18½ inches by 18 inches and four of 18 inches by 24 inches, two Ideals 18½ inches by 18 inches, four McIntosh & Seymour 18½ inches by 18 inches, and two others of the same make 19 inches by 23 inches, aggregating about 5,500 h. p.

The engine room floor is supported on very heavy iron floor sills, which are laid on the smoothed surface of substantial stone walls, which, in turn, are supported by a solid foundation which is so firm that scarcely a tremor is felt from the movement of the machines when all the engines, and dynamos are in action. This part of the design of this station is especially meritorious, as it is seldom that the operation of so much machinery is carried on so quietly that no noise or vibration is noticeable in adjoining rooms of the same building. This is largely due to the fact that the engine room floor does not touch and is not supported by the side walls.

Directly above the engines are the dynamos, 32 in number, each engine driving two dynamos, one from either fly-wheel, by the use of double leather belts, which incline but a few degrees from the vertical. This style of driving is found most suitable, as the dynamos are run in pairs, on the three-wire system, but are so arranged that any two machines can be operated together, cross-connections being supplied and each machine equipped with reversing switch.

The dynamo plant consists of twenty No. 32 and twelve No. 60



INTERIOR VIEW, CHICAGO EDISON STATION.

Edison machines, arranged in two rows, the centre line between the rows being directly over the line of the crank shafts of the engines; the engines being set so that the shafts are in line and each alternate engine faces in the opposite direction.

The dynamo room, of the same size as the engine room, has a very high ceiling, and the roof is composed almost entirely of heavy plate glass, affording plenty of light during the day and ample ventilation at all times, so that the room is never uncomfortably warm—a feature that is beneficial to the machines as well as to the attendants.

Ranged along one side of the room are the bus bars, to which the machines are connected by heavy copper bars that lead from the machines to the ceiling, then across to the wall and down to the bars. The bus bars are 2½ inches by ½ inch, and are in multiple to a capacity of 25,000 amperes. Above the bus bars are arranged the feeders, supplied with the necessary ammeters and cut-outs, which lead to the centres of distribution about the city, of which there are 36 supplied from this station, some of them being located as far as nine blocks, or more than a mile away. The feeders, after

leaving the dynamo room, are of rubber covered and braided cable to where they enter the subways, which are of the Edison type, consisting of iron tubes containing the insulated wires embedded in insulating composition, composed mainly of asphaltum. Each of the pipes contain two pressure wires in addition to the three wires of that circuit, but the middle, or neutral, conductor is only one-third the sectional area of the others, but is of sufficient size to carry the load that would be thrown on it in case of a break down to one of the other conductors. Each set of pressure wires is fitted with indicators, which are in plain sight at all times and marked with the number of the circuit to which it belongs.

This station supplies current under low tension only, the voltage at the generators being 240 with an average of 230 at the centres of distribution.

All the feeders leave the station on the Adams street side at a depth of eight feet below the surface, but soon rise to within twelve inches of the pavement, being buried at a sufficient depth to escape accidental injury while still being convenient for repairs.

The distribution boxes, which are of the usual Edison type, are located at the street intersections, a few feet from the curb, in the immediate vicinity of the buildings to which current is to be supplied. In some cases the demand for current has been so great that the carrying capacity of some of the circuits, owing to their great length, has been overtaxed; but this difficulty has been overcome by connecting a "boosting" circuit from another station to that particular centre of distribution, thus more nearly equalizing the potential all around.

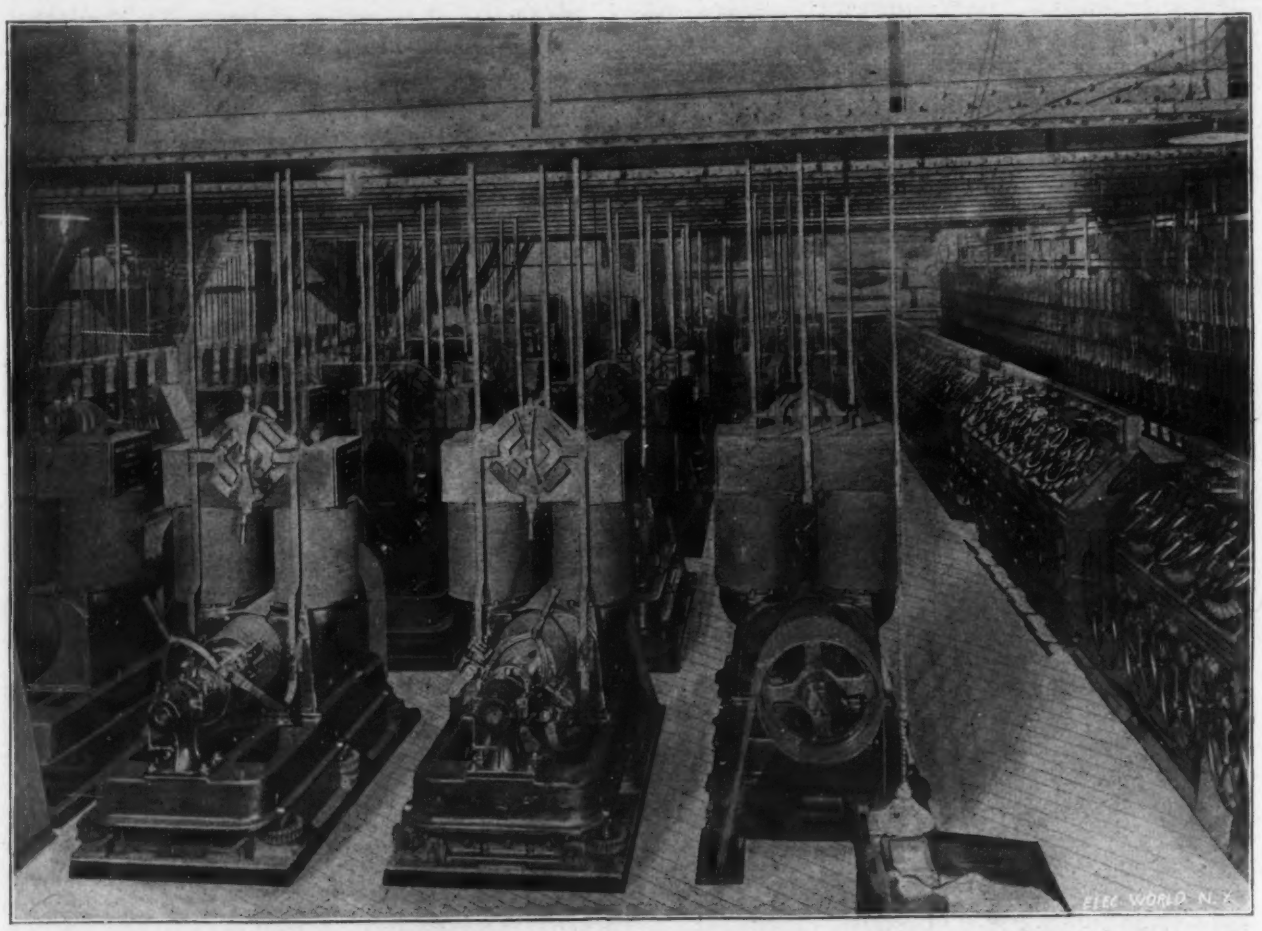
Ten Heine boilers are required for furnishing the steam for this plant. These consist of four of 325 h.p., one of 500 and five of 375 h. p. The boilers are located on two floors, five on each, and each boiler is separately connected to the mains, so that any one can be laid off when desired without interfering with the others. The boiler rooms are each 74 by 44 feet. Two steam pipes, 18 inches in diameter, are arranged so that either or both may be used as the conditions require, and an 8-inch supply pipe connects with each engine.

Hawley down-draught furnaces are used under all the boilers. These are connected with a chimney 150 feet high, which give a draught equal to a pressure of three-quarters inch of water, ample for all the requirements. The down-draught furnaces were put in but a short time ago, a different kind having been previously in use, but constant trouble with the city smoke inspectors made a smokeless furnace necessary.

Coal storage is provided for on the third floor, above the boilers, and has a capacity sufficient for a four days' supply. At the present time the consumption of fuel is at the rate of 110 tons per day of 24 hours, but this is less than the amount that was required during the past winter. The coal is raised to the storage room by electric elevators.

The heating of the building is by the use of exhaust steam, by the Williams system, which provides circulation by pumping out the returns.

City water is used for supplying the boilers, and is partly purified before use by being passed through a 2,000-h. p. Baragwanath heater, where the temperature is raised to about 210 degrees and a portion of the mineral impurities precipitated before it enters the boiler. This heater contains 2,000 square feet of heating surface and weighs 11.5 tons. It is the largest heater built by the Baragwanath Company. There is also a 1,000-h.p. Berryman heater in use in connection with the one described.



Interior View, Chicago Edison Station.

There are four boiler feed pumps of the Worthington duplex tpye, each being 10 inches by 6 inches by 10 inches.

The engines are all ready for use at a moment's notice, being kept hot by being open to the exhaust when not in use. This precaution is absolutely necessary, for sometimes the load comes on with amazing rapidity, requiring the utmost exertions of the attendants for a few moments, as was the case one day lately when the load increased 8,000 amperes within ten minutes' time. Similar large increases of load within a few minute are not uncommon when thunderstorms are coming up, for then it gets quite dark.

Under the present management the service of this company has been all that could be desired, as there have been but very few interruptions of service from any cause.

The average load of this station during the past winter was 9,000 amperes, supplied mostly to lamps, but the amount used for power purposes has been considerable, as there are 1,500 h. p. of motors attached to the circuits. The motors are used for all conceivable purposes, a number being employed for operating elevators, and

many for driving machinery and hoisting. The maximum load was 19,000 amperes.

A complete set of records of all happenings to the plant is kept in a most systematic manner, and such "troubles" as do occur are attended to without delay, the men for this purpose being on duty or within call at all times, although their services are seldom called for to attend anything of a serious nature. The worst difficulty that has occurred for some time was a slight fire among the cables, one afternoon some weeks ago, when some one without authority turned in the fire alarm. The department responded with their usual alacrity, and before it could be prevented deluged the cables, making things lively for the station men, but not interrupting the service except for a couple of hours. The bravery and energetic actions of our fire departments are well known and commendable, but their knowledge of electricity is not as great as is sometimes desired.

An annex is connected with this station. It contains two Armington & Sims engines, each of 450 h. p., and four No. 60 Edison dynamos, which are kept in continual service to help the main plant. This annex was built in November, 1892, and the installation of the machinery called for the most careful and competent engineering ability, as the only place that could be found for it in that neighborhood was in a basement, just across the alley in rear of the station.

To get the machines into this place required that a portion of the foundation walls of the building be removed. The machines, taken apart as far as was advisable, were first lowered to the tunnel, which had been prepared for the 10-inch steam pipes from the boiler plant, and then passed through on rollers to the position they now occupy. This was a difficult task, as the tunnel was small, and the space that could be utilized no more than required, but the task was finally accomplished without accident.

This station has done good work during its time, but the locality has outgrown its capacity, and it will be discontinued when the new Harrison street station is finished, for the work can be done more economically in the new station with triple expansion engines and latest improved devices than with the engines with which this station is now equipped. The station bus bars are ready for being connected to the 1⅞ inch by 5 inch conductors which lead underground and through the company's private tunnel under the river to the Harrison street station, but as this station will not be ready for some months, the old station will continue its accustomed activity, and be held in reserve for some time.

An Electrically Cooked Banquet.

A banquet was tendered recently in London by Sir David Salomons and the directors of an electric lighting company, in which everything was cooked by electricity; there were 120 guests, and the number of kilowatt-hours used was 60, for cooking ten courses, or one-half a kilowatt-hour per person; this, at the cost of eight cents per kilowatt-hour, which is what that company intends to charge for electricity for cooking purposes, makes the cost of the heat four cents per person for ten courses. The banquet is described in detail by some of our English contemporaries.

Permeability of Steel.

BY MAX OSTERBERG AND MILBOURNE MUNROE.

The samples of steel whose magnetic properties are given in the accompanying curves and tables were generously furnished by the Bethlehem Iron Company, together with a complete chemical analysis of each specimen. The samples are of regular commercial grades, and formed part of the exhibit of this company at the Chicago World's Fair.

The method followed in determining the magnetic properties was that usually known as Hopkinson's. A large forging of the shape and dimensions indicated in Fig. 1 was used, serving as a short-circuiting device for the magnetic lines of force, so that only that length of bar is considered which goes from *M* to *M* of the block,

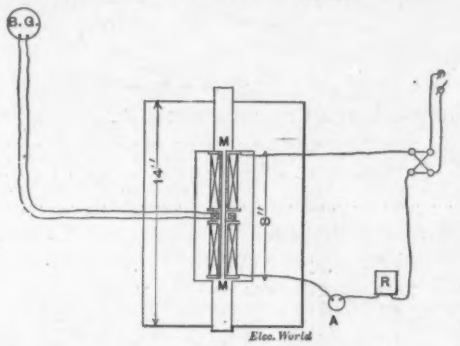


FIG. 1.

which in the present case was eight inches. The coils which served as a primary had first 900, then 2,000 turns, while the current used was varied from .07 to 6 amperes. The secondary, or exploring coil, consisted of 90 turns of small wire wound on a spool of hard rubber. The test pieces were cut in two and joined right at the end of the exploring coil, so that when one part of the piece was pulled away, the exploring coil, being attached to a spring, would fly out. A d'Arsonval ballistic galvanometer, the complete period of which was fifteen seconds, a reversing switch in the primary, which served as an excellent device with which to bring the galvanometer to rest, an ammeter and variable resistances formed the rest of the apparatus.

The experiments were performed as follows: A steady current was passed through the primary, and then the movable piece was pulled out. The exploring coil necessarily cut all the lines of force in flying out, thus generating a current which gave the galvanometer needle a kick. The number of scale divisions multiplied by the

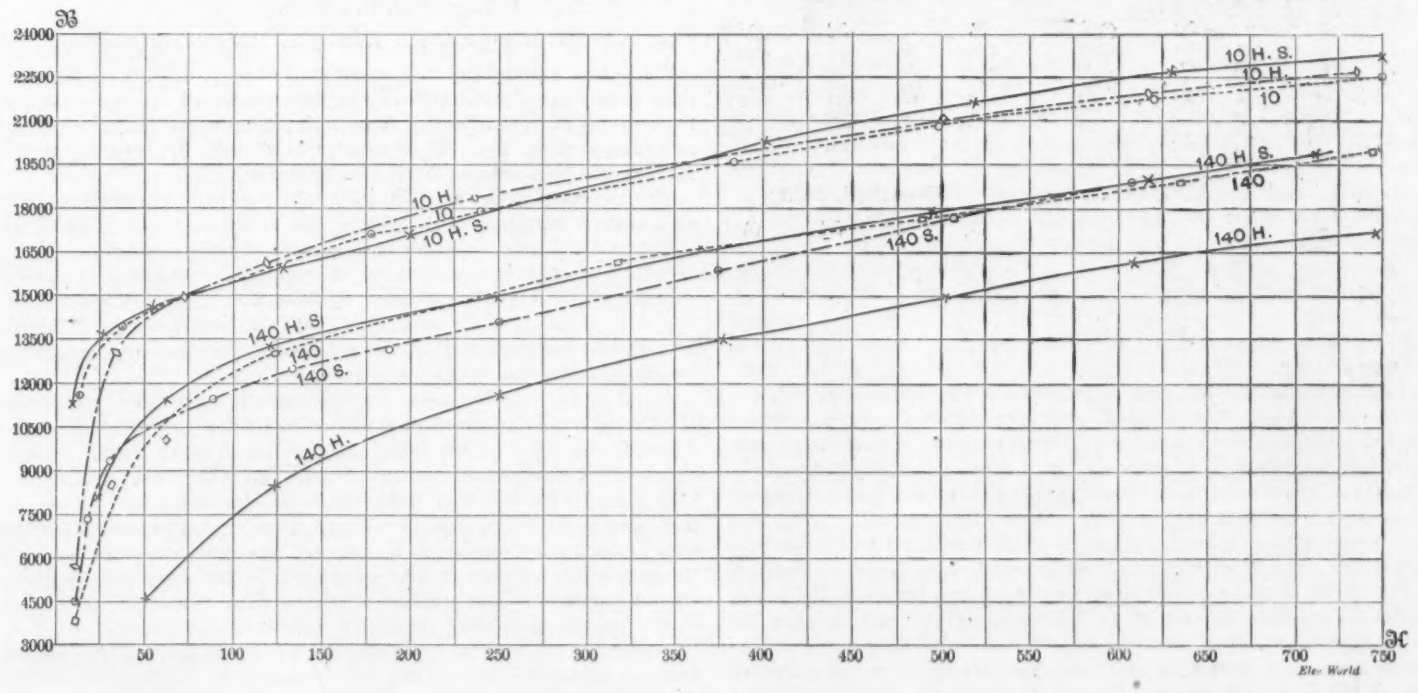


FIG. 2.

galvanometer constant, previously determined, gave then the quantity (Q) of electricity which was induced in the secondary. From the theory of the ballastic galvanometer,

$$\frac{10\ QR}{Z} = \Phi$$

where R = resistance of the secondary circuit;
Z = number of turns of exploring coil;
Φ = flux.

Knowing Φ we can find μ, for

$$\Phi = \frac{4\pi NC\ 10^{-1}}{\frac{l}{s\ \mu}}$$

$$\therefore\ \mu = \frac{10\ l\ \Phi}{4\pi\ NCs}$$

where NC = ampere turns in primary;
l = length of test piece;
s = cross-section test piece.

We can also find $\mathfrak{B}$ from Φ, for $\Phi \div s = \mathfrak{B}$
where $\mathfrak{B}$ = number of lines of force per sq. cm, or gausses;
$\mathfrak{B}'' = \mathfrak{B} \times 6.45$ = " " " " inch.
Finally we determine $\mathfrak{H}$, for $\mathfrak{H} = \mathfrak{B} \div \mu$.

The following tables give the results of experiments:

A.—BASIC OPEN HEARTH STEEL COMPOSITION.

Carbon	.07
Manganese	.22
Phosphorus	.008
Sulphur	.032
Silicon	.053

	Annealed, 10 S				Plain, 10			
	$\mathfrak{B}$	μ	$\mathfrak{H}$	$\mathfrak{B}''$	$\mathfrak{B}$	μ	$\mathfrak{H}$	$\mathfrak{B}''$
1	9,110	1,052	8.67	58,760	11,466	927	124	73,956
2	11,498	929	12	74,162	13,883	362	38	89,546
3	14,626	197	74	94,338	14,721	238	62	94,950
4	15,992	129	124	103,148	16,114	130	124	103,935
5	17,852	72	248	115,145	17,943	72	249	115,732
6	19,546	53	369	126,007	19,616	51	384	126,523
7	21,693	35	620	139,920	21,630	35	618	139,514
8	22,592	30	753	145,718	22,506	30	750	145,164

	Hardened and Annealed, 10 HS				Hardened, 10 H			
	$\mathfrak{B}$	μ	$\mathfrak{H}$	$\mathfrak{B}''$	$\mathfrak{B}$	μ	$\mathfrak{H}$	$\mathfrak{B}''$
1	11,219	1007	11	72,363	5,422	438	12	34,972
2	13,574	488	28	87,552	13,387	361	37	86,346
3	14,689	237	62	94,744	15,000	20	74	96.750
4	15,371	160	96	99,143	16,177	131	124	104,342
5	16,052	115	139	103,535	18,253	74	247	117,732
6	16,982	85	200	109,534	20,948	42	499	135,114
7	21,631	42	515	139,520	22,066	36	613	142,326
8	23,341	31	753	150,549	22,655	305	743	146,125

B.—ACID OPEN HEARTH STEEL COMPOSITION.

Carbon	1.406
Manganese	.470
Phosphorus	.032
Sulphur	.034
Silicon	.077

	Annealed, 140 S				Plain, 140			
	$\mathfrak{B}$	μ	$\mathfrak{H}$	$\mathfrak{B}''$	$\mathfrak{B}$	μ	$\mathfrak{H}$	$\mathfrak{B}''$
1	4,401	395	11	28,386	3,946	319	12	25 452
2	7,685	363	21	49,508	8,863	239	37	57,166
3	9,607	265	37	61,965	10,165	164	62	65.564
4	11,403	128	89	73,549	13,078	106	123	84,353
5	12,520	94	133	80,754	15,080	61	247	97,266
6	14,008	56	250	90,351	16,444	44	374	106,064
7	17,757	35	507	114,533	17,665	36	490	113,939
8	18,904	31	610	121,931	20,050	27	743	129,323

	Hardened and Annealed, 140 $\mathfrak{H}$S				Hardened, 140$\mathfrak{H}$			
	$\mathfrak{B}$	μ	$\mathfrak{H}$	$\mathfrak{B}''$	$\mathfrak{B}$	μ	$\mathfrak{H}$	$\mathfrak{B}''$
1	7,996	323	25	51,574				
2	11,498	186	62	74,162	4,550	92	49	29,348
3	13,203	107	124	85,159	8,554	69	124	55,173
4	14,972	60	250	96,569	11,682	47	249	75,349
5	16,735	45	372	107,941	13,426	36	373	86,598
6	17,807	36	495	114,855	15,060	30	502	97,137
7	19,090	31	616	123 131	16,152	26	621	104,180
8	20,203	27	748	130,309	17,231	23	749	111,140

The curves in Fig. 2 represent only two different qualities of steel, each of which was treated in four different ways. Seven distinct curves were obtained, some entirely different at low points of saturation and intersecting at somewhat higher points. These two qualities furnish ample proof of the fact that all curves used nowadays—that is, those to which the general public has access—are almost useless. There is at least as large a difference in different makes of wrought iron as in steel, and, therefore, to use a conventional curve which happens to be found in textbooks is not only very unscientific, but it is also misleading and inaccurate. Prof. Ewing states: "At every stage the susceptibility and permeability are less in steel than in iron," but this is in practice by no means the case. Of course, if a good quality of wrought iron is compared with a poor quality of steel this will be true, but it is safe to say that a great deal of the wrought iron used commercially is less impure than the quality of steel (No. 10) tested. In a paper read at the Chicago meeting of the American Institute of Electrical Engineers by Messrs. Thompson, Knight and Bacon, a number of cast steel curves are to be found which intersect the conventional Hopkinson wrought iron curve and those of wrought iron samples tested by these gentlemen themselves. This phenomenon may be due to the chemical constitution of the specimens tested, as the impurities in wrought iron are not as deleterious at lower saturations as at high ones, while in steel the reverse might be true.

In the course of experimenting it was invariably found that, the softer the steel, the more difficulties were encountered in getting satisfactory results. A little heating at the end of the test pieces would make quite a marked difference, while in the hard steel it was comparatively easy to get good results. Mild steel is probably more susceptible to magnetic influences, and any slight variation might have considerable bearing. It might be said that mild steel is in a kind of unstable equilibrium.

Practical Notes on Dynamo Calculations. IX.

BY ALFRED E. WIENER.

b.—Radiating Surface of Ring Armatures.

In ring armatures the construction and mounting of the core may be such that either one, two, three, or all four sides of the cross section are in contact with the air, but in modern machines, almost

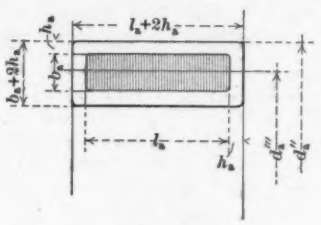


FIG. 20.

without exception, all four, or at least three, of the surfaces constituting the ring are radiating areas (Fig. 20).

In the first mentioned case (four sides) we have the formula:

$$O_a = 2 \times d_a''' \times \pi \times (l_a + b_a + 4 \times h_a), \qquad (45)$$

and in the latter case (three sides):

$$O_a = d_a'' \times \pi \times (l_a + 2\ h_a) + 2 \times d_a''' \times \pi \times (b_a + 2\ h_a) \qquad (46)$$

O_a = radiating surface of armature, in square inches;
d_a'' = external diameter of armature, in inches;
d_a''' = mean diameter of armature core, in inches;
l_a = length of armature core, in inches;
b_a = radial depth of armature core, in inches;
h_a = height of winding space, in inches.

18.—Specific Energy Loss. Rise of Armature Temperature.

While the amount of the consumed energy, W_a, formula (42), determines directly the quantity of heat generated in the armature, the amount of heat liberated from it depends upon the size of its radiating surface, upon its circumferehtial velocity, and upon the ratio of the pole area to the radiating surface.

The most important of these factors in the heat conduction from an armature naturally is the size of the radiating surface, while the speed and the ratio of polar embrace are of minor influence only; and it is, therefore, the ratio of the energy consumed in the armature to the size of the cooling surface, that is, the *specific energy loss*, which limits the proportion of heat generated to heat radiated, and which consequently affords a measure for the degree of the temperature increase of the armature.

A. H. and C. E. Timmermann,* of Cornell University, who made the armature radiation the subject of their paper read before the American Institute of Electrical Engineers, in May, 1893, from a series of elaborate experiments drew the following conclusions:

(1.) An increase of the temperature of the armature causes an increased radiation of heat per degree rise in temperature, but the ratio of increase diminishes as the temperature increases, and an increase of the amount of heat generated in the armature increases the temperature of the armature, but less than proportionately.

(2.) As the peripheral velocity is increased, the amount of heat liberated per degree rise in temperature is increased, but the rate of increase becomes less with the higher speeds.

(3.) The effect of the field poles is to prevent the radiation of heat; as the percentage of the polar embrace is increased, the amount of heat radiated per degree rise in temperature becomes less.

*A. H. and C. E. Timmermann, Transactions Am. Inst. of Elec. Eng., Vol. X., p. 336. (1893.)

Combining these results with the data and tests of various dynamos, the author finds the following values given in Table XXX of the temperature increase per unit of specific energy loss, that is, for every watt of energy dissipated per square inch of radiating surface, under various conditions of peripheral velocity and polar embrace:

TABLE XXX.—SPECIFIC TEMPERATURE INCREASE IN ARMATURES.

Peripheral velocity in feet p. sec.	Rise of temp. per unit of specific energy loss, in degrees Centigrade, τ_a — Ratio of pole area to total radiating surface.						
	.8	.7	.6	.5	.4	.3	.2
0	110°	100°	95°	90°	86°	83°	80°
10	80	74	70	67	64	62	60
20	64	61	58	56	54	52	50
30	55	53	51	49½	48	46½	45
40	50	48½	47	46	45	44	43
50	48	47	46	45	44	43	42
75	47	46	45	44	43	42	41
100	46	45	44	43	42	41	40
150	45	44	43	42	41	40	40

In Fig. 21 these temperatures are represented graphically; Curves I., II. . . . . VII., corresponding to Columns 2, 3 . . . 8, of Table XXX., respectively.

Multiplying this specific temperature increase by the respective

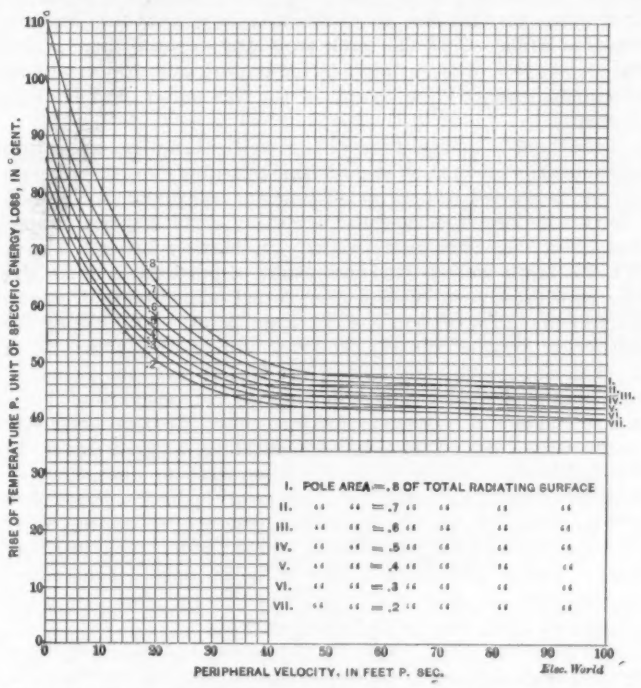

RISE OF TEMPERATURE P. UNIT OF SPECIFIC ENERGY LOSS, IN ° CENT.
PERIPHERAL VELOCITY, IN FEET P. SEC.
I. POLE AREA = .8 OF TOTAL RADIATING SURFACE
II. " " = .7 " " " "
III. " " = .6 " " " "
IV. " " = .5 " " " "
V. " " = .4 " " " "
VI. " " = .3 " " " "
VII. " " = .2 " " " "
Elec. World

FIG. 21—SPECIFIC TEMPERATURE INCREASE IN ARMATURES.

specific energy loss, the rise of temperature in any armature can be found from:

$$t_a = \tau_a \times \frac{W_a}{O_a} \qquad (47)$$

where: t_a = rise of temperature in armature, in degrees Centigrade;

τ_a = specific temperature increase, or rise of armature temperature, per unit of specific energy loss, from Table XXX. or Fig. 19;

W_a = total energy consumed in armature, in watts, formula (41);

O_a = radiating surface of armature, in square inches, from formula (44), (45) or (46) respectively;

$\frac{W_a}{O_a}$ = specific energy loss, *i. e.*, watts energy loss per square inch of radiating surface.

Empirical Formula for Heating of Drum Armatures.

From tests made with drum armatures, Ernst Schulz† derived an empirical formula, which, when translated into our symbols and units, becomes:

$$t_a = .00045 \times \frac{\mathfrak{B}_a \times P \times N \times M}{O_a} \qquad (48)$$

t_a = rise of armature temperature, in degrees Centigrade;

† Ernst Schulz, "*Elektrotechn. Zeitschr.*," Vol. XIV., p. 367 (June 30, 1893). "THE ELECTRICAL WORLD," Vol. XXII, p. 118 (Aug. 12, 1893).

$\mathfrak{B}_a$ = magnetic density in armature body, in lines per square inch;

P = number of pairs of magnet poles;

N = Number of revolutions per minute;

M = mass of iron in armature core, in cubic feet;

O_a = armature surface, in square inches. (In his calculations, Mr. Schulz, for convenience, takes the external surface of the cylindrical part, $d_a'' \pi \times l_a + \frac{d_a''^2 \times \pi}{2}$, instead of the radiating surface proper, formula (44), but no fault arises from this, as the constant takes care of the difference.)

The numerical factor depends upon the units chosen, upon the ventilation of the armature, upon the quality of the iron, and upon the thickness of the lamination, and consequently varies considerably in different machines. For this reason, it is advisable not to use formula (48), except in case of calculating an armature of an existing type for which this constant is known by experiment. In the latter case, Schulz's formula, although not as exact, is even more convenient than the direct equation (47), which necessitates the separate calculation of the energy losses, while (48) contains the factors determining these losses, and therefore will give the result quicker, provided that the numerical factor has been previously determined from similar machines. For various drum armatures experimented upon by Mr. Schulz, the constant varied between .0003 and .0005, and averaged about .00045.

19. Circumferential Current Density of Armature.

An excellent check on the heat calculation of the armature, and in most cases all that is really necessary for an examination of its electrical qualities, is the computation of the circumferential current density of the armature. This is the sum of the currents flowing through a number of active armature conductors corresponding to unit length of core-periphery, and is found by dividing the total number of amperes all around the armature by the body circumference:

$$J = \frac{K \times \frac{C}{2P}}{d_a \times \pi} \qquad (49)$$

J=Circumferential current density, in amperes per inch length of core-periphery;

K=Total number of armature conductors, all around periphery;

C=Total current generated in armature, in amperes;

$2P$=Number of electrically parallel armature portions (number of poles);

$\frac{C}{2P}$= Current flowing through each conductor, in amperes;

$K \times \frac{C}{2P}$= Total number of amperes all around armature; this quantity is called "Volume of the armature current," by W. B. Esson, and "circumflux of the armature," by Silvanus P. Thompson;

d_a = diameter of armature-body, in inches; in case of a toothed armature, on account of the considerably greater winding depth, the external diameter, d_a'', is to be taken instead of d_a, in order to bring toothed and smooth armatures to about the same basis; for a similar reason, for an inner-pole dynamo, the mean diameter, d_a''', should be substituted for d_a.

By comparing the values of J found from (49), with the average given in the following Table XXXI, the rise of the armature temperature can be approximately determined, and thus a measure for the electrical quality of the armature be gained. The quality of the proportion between the armature winding and the dimensions of the core is indicated by the amount of increase of the armature temperature. If the latter is too high, it can be concluded that the winding is proportioned excessively, and either should be reduced or divided over a larger armature surface.

TABLE XXXI.—RISE OF ARMATURE TEMPERATURE, CORRESPONDING TO VARIOUS CIRCUMFERENTIAL CURRENT DENSITIES.

Circumferential Current Density.	Rise of Armature Temperature.	
	High-speed (belt-driven) dynamos.	Slow-speed (direct-driven) dynamos.
50 to 100	15° to 25°C	10° to 20°C
100 " 200	20 " 35	15 " 25
200 " 300	30 " 50	20 " 35
300 " 400	40 " 60	25 " 40
400 " 500	50 " 70	30 " 45
500 " 600	60 " 80	35 " 50
600 " 700	70 " 90	40 " 60
700 " 800	80 " 100	50 " 70

The difference in the temperature-rise at same circumferential current density for high speed and low speed dynamos (Columns 2 and 3 respectively, of the above table) is due to the fact that, other conditions being equal, in a slow speed machine less energy is absorbed by hysteresis and eddy currents; that, consequently, less total heat is generated in the armature, and, therefore, more cooling surface is available for the radiation of every degree of heat generated.

20. Load Limit and Maximum Safe Output of Armatures.

From Table XXXI also follows that, according to the temperature increase desired, the load carried by an armature varies between 50 and 800 amperes per inch of circumference, or between about 150 and 2,500 amperes per inch of armature diameter. As a limiting value for safe working, Esson* gives 1,000 amperes per inch diameter for ring armatures, and 1,500 amperes for drums. Kapp† allows 2,000 amperes diametral current density for diameters over 12 inches as a safe load.

Taking 1,900 amperes per inch diameter (= 600 amperes per inch circumference) as the average limiting value of the armature-load, corresponding to a temperature rise of about 70 to 80 degrees Centigrade (see Table XXXI), we have:

$$K \times \frac{C}{2P} = 1{,}900 \times d_a, \qquad (50)$$

and since, for the output of a dynamo we can write (see Part II., chap. 1.)

$$W = E \times C = \frac{K \times \Phi \times N}{P \times 10^8 \times 60} \times C, \qquad (51)$$

in which

W = The output of dynamo, in watts;
E = Total E. M. F., generated in armature, in volts;
C = Total current, " " " " amperes;
K = Number of armature conductors;
Φ = Number of useful lines of force;
N = Speed in revolutions per minute;
P = Half number of parallel armature-circuits (number of pairs of poles);

We obtain for the limit of the output, by inserting (50) into (51):

$$W = \frac{1{,}900 \times d_a \times \Phi \times N}{10^8 \times 30} = \frac{63 \times d_a \times \Phi \times N}{10^8} \qquad (52)$$

But the useful flux, Φ, is the product of gap area and field-density, or

$$\Phi = \frac{d_a \times \pi}{2} \times \beta', \times l_a \times \mathfrak{IC},$$

and, consequently, (52) becomes

$$W = \frac{63 \times d_a \times \frac{d_a \times \pi}{2} \times \beta' \times l_a \times \mathfrak{IC} \times N}{10^8}$$

$$= d_a^2 \times l_a \times \beta' \times \mathfrak{IC} \times N \times 10^{-6}; \qquad (53)$$

W = Maximal safe output of armature, in watts;
d_a = Diameter of armature core, in inches;
l_a = Length " " "
β' = Percentage of useful gap-circumference; to be taken somewhat higher than percentage of polar arc, to allow for circumferential spread of the lines of force, see table XXXII.
$\mathfrak{IC}$ = Field density, in lines of force per square inch;
N = Speed in revs. per minute.

Average values for β' taken from practice, are given in the following table:

TABLE XXXII.—PERCENTAGE OF EFFECTIVE GAP CIRCUMFERENCE FOR VARIOUS RATIOS OF POLAR ARC.

Percentage of Polar Arc. β	Percentage of Effective Gap Circumference. β'			
	2 poles.	4 to 6 poles.	8 to 12 poles.	14 to 30 poles.
1.00	1.00	1.00	1.00	1.00
.95	.98	.97	.965	.96
.90	.96	.94	.93	.92
.85	.94	.905	.89	.88
.80	.91	.87	.85	.84
.75	.88	.835	.815	.80
.70	.85	.80	.78	.76
.65	.82	.765	.74	.72
.60	.78	.73	.70	.68
.55	.74	.69	.665	.64
.50	.70	.65	.625	.60

(*To be Continued.*)

* Esson, Journal I. E. E. XX. p. 142. (1890.)
† Kapp, S. P. Thompson's Dynamo Electric Machinery, 4th Ed. p. 439.

Economical Steam Engines and Wasteful Boilers.

According to Mr. Rosenthal, one of the speakers in the discussion on Mr. Crompton's recent paper, says the London *Electrical Review*, Lancashire boilers in Lancashire factories only give an evaporation of 6 to 7 lbs. per pound of coal. Now the ordinary Lancashire factory, with compound steam engines, secures a horse power hour for 1¼ lbs. of coal, from which it follows that compound engines use only 10½ to 12 lbs. of steam per horse power hour. If, therefore, Mr. Rosenthal be correct, it would be found possible, by the exercise of that "great skill and unwearying attention" spoken of by Mr. Crompton, to get 1 horse power hour from only about 6 lbs. of steam. Mr. Rosenthal shouldmake further inquiries into the practice of the ordinary co-operative concerns in coal consumption, for his figures won't stand criticism. He also make thefurther error of classing Lancashire water-tube and ordinary tubular boilers on the same plane, as regards smoke prevention. Now there is absolutely no similitude whatever. The water-tube boiler resembles the upright boiler in these respects, for in both the flames and gases from the furnace rise vertically from the fire surface, whereas in the Lancashire, the marine, the underfired, and similar furnaces the gases sweep along the fire surface and mingle at one common area over the bridge, and it is just this important difference that non- xperts entirely overlook. Take, for example, the locomotive boiler without a brick arch, and where can there be found a boiler that produces smoke so freely? The furnace is of the same class as that of the vertical or water-tube boiler. Add the brick arch, and at once there is introduced an entirely different regime, for the brick arch gives in effect the common commingling point of the flue boiler, and smokelessness results.

In Broadbent's modification of the vertical boiler, an immense improvement is effected as regards smoke, simply because the above principle is carried into effect. The Lancashire and marine boilers are correct in form for smoke prevention, but they are wrong in material, for they have water-cooled combustion boxes. The ideal boiler, so far as we can read the results of practice, is one with the whole, or a great part, of its furnace lined with firebrick, and with Serve ribbed tubes beyond the flaming point. Experience alone could decide how far to carry the brick lining, but from the fact that even now, with care, Lancashire boilers are smokeless, it is only a matter of adding a margin to cover the mistakes of the fireman. If makers of water-tube boilers could divorce their minds from the vulgar error that a furnace must be hugged by cold surfaces, and would redesign their boilers on sounder lines, they would probably beat the Lancashire boiler at all points except that of steady steaming, which they could only secure by adding to their water capacity, and the power to use dirty water, when this is compulsory. Unless they do this, they will continue to demand costly smokeless fuel, which is of all fuels most distant from the majority of the power-using centers of this country.

It will be noted that, while Mr. Crompton has said much on the subject of forcing boilers, he has, even in his corrected reply, not given a single figure bearing upon the rate of fuel combustion per foot of grate. Vague generalities about doing 50 per cent. beyond its normal power tell nothing. The normal horse power of a Babcock boiler is based on 30 lbs. of steam per horse power hour; put such a boiler to drive a 15-lb. engine, and at once it is doing 100 per cent. beyond its normal.

It is simply begging the question to omit the amount and rate of coal consumption when bragging about results in forcing a boiler. Rated horse power is simply a later form of the old nominal horse power—utterly valueless. Of what possible good can it be to talk in one breath of a boiler horse power which means 30 lbs. steam and a Willans, Sulzer or other modern engine horse power which means 12 lbs. of steam, more or less.

We had hoped that the nominal horse was a dead one, and little to be expected at a meeting of electrical engineers. It is to be regretted that Mr. Crompton in his reply adheres to the statement that an economizer can cover a stoker's mistakes. The idea is as mischievous in practice as it is erroneous in conception. Never mind, we are told in effect, how cold you allow the furnaces to become, so long as you have an economizer to take the heat up—to absorb heat never generated! When the stoker is firing badly, he is wasting no heat to the economizer—he is not producing any heat to waste. How, then, can the economizer pick up what has not been dropped? Bad firing is bad for every class of boiler, and equally so for the feed heater, and Mr. Crompton's ideas on this question are entirely opposed to all known physical facts, and it would be interesting to have him explain how he arrives at his conclusions.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

COMPILED FROM PRINCIPAL FOREIGN ELECTRICAL JOURNALS BY CARL HERING.

ELEC. WORLD, N.Y.

ELECTRO-PHYSICS.

A New Phenomenon.—In a paper by Mr. Lehmann in "Wied. Ann.," vol. 52, No. 7, a translation of which is given in the Lond. "Elec.," June 22, he describes the following phenomenon: if a 70 volt current is passed through an aqueous solution of Congo red, a sharply marked halo is formed around both electrodes, having a blue color at the anode and "somewhat paler (red?) than the rest of the solution" at the cathode, but divided from it by a dark boundary; the two halos extend rapidly and finally meet in the middle, at which moment a dark blue pigment is precipitated at that point on the side toward the anode, while toward the cathode the solution becomes colorless; at the same time the liquid shows great disturbance where the dark blue and the colorless strata meet, while the rest remains perfectly quiet; the experiment is more conveniently made by thickening the solution with gelatine, sugar or glycerine. He describes the nature of the phenomenon as follows: the dissociated molecules appearing at the electrodes are given charges of the same sign by contact with them, and approach each other along the lines of force until they encounter molecules with which they combine chemically. The examination of a large number of other solutions gives precisely corresponding results, sometimes with very interesting details, among them being gelatinous aqueous solutions of marine blue, saffranin, chrysoidin, etc. Whether colorless solutions also show the phenomenon, it is difficult to say, since the migration of the halos is only indicated by the formation of color, not by the formation of stripes. If the solution contains fine dust particles, a jerky motion of these is often observed where the edge of such a halo passes a particle. By filling a liquid with numerous small particles, the migration of the halos may be observed by means of changes in their density of distribution with nearly the same ease, commercial liquid India ink being especially suited for this purpose, if thickened with sugar or glycerine.

Hertzian Waves.—In connection with the subject mentioned in the Digest, June 30, under "Causes of Short Circuits," the Compiler has received a communication from Prof. Elihu Thomson, in which he states that as early as 1877, while working with a Ruhmkorff induction coil, one terminal of which was grounded and the other attached to an insulated metallic body, he and Prof. Houston noticed that when sparks were passing between the terminals of the coil, it was possible to obtain minute sparks from all the metallic bodies in the immediate neighborhood in the same room, and that delicate sparks could be obtained between small pieces of metal held in the hand near metallic bodies in any part of the building, even though the pieces were not grounded; these, he said, could only have been Hertzian effects. In connection with Prof. Lodge's coherer (see Digest July 7), Prof. Thomson relates the case of an electro-plater who found that he could not conduct his silver plating operations during thunder storms; it was found that he had considerable excess of battery power, and that his connections included a number of bad contacts of high resistance; under these circumstances a flash of lightning would cause coherence at the bad contacts, thus increasing the conductivity so as to cause an excess of flow of current. He suggests the use of Dr. Lodge's instrument in the study of waves propagated during thunder storms, about which practically very little knowledge exists.

Work of Hertz.—Prof. Lodge's lecture is concluded in the Lond. "Elec.," June 22; he gives some interesting experiments with his coherer (see Digest last week) and describes some optical and other experiments.

Electrostatic Rotation in Rarified Gases.—A translation of a paper by Mr. Arno is published in the Lond. "Elec." and "Elec. Rev.," June 22; he uses a small millwheel made of four very delicate brass vanes, mounted in a glass bulb containing very highly rarified air; by using a completely metallic mill-wheel, he was sure of eliminating all direct action of the rotating field upon the vanes of the wheel and of ascertaining the new effects due to the presence of the rarified gases; this apparatus is introduced between two pairs of copper strips arranged like a cylinder around this bulb cut longitudinally into four pieces; the brass vanes then commence to rotate in the same direction as the field itself; with an alternating current of a frequency of 40, a distance of 15 cm. between the strips, and a difference of potential of 7,500 volts, the intensity of the field was 1.67 C. G. S. electrostatic units, and the metallic wheel acquired a velocity of 50 turns per minute. Experiments showed that in the open air no such rotation will take place even in very intense fields, and that the cause of the phenomenon must therefore be looked for in the forces developed inside of the bulb, which are indirectly excited by a special action exercised by the rotating field upon the rarefied gases.

MAGNETISM.

Magnetization of Iron.—A Royal Society paper by Messrs. Hopkinson & Wilson is abstracted very briefly in the Lond. "Elec. Rev.," June 2; the object was to investigate the effects of the electric currents induced in the iron in delaying the reversal of the magnetism in the centre of the core when the magnetizing current is reversed; the solid cylindrical magnet had a diameter of four inches and formed a closed magnetic circuit; exploring coils of fine wire were embedded in the iron, and the currents in the coils were observed when the main current was reversed, these currents in some cases lasted over half a minute, in cylinders of different diameters similar events occur, but at times proportional to the squares of the diameters of the cylinders; some conclusions are drawn regarding the effects of local currents in the cores of transformers and armatures, but they are not given in the abstract.

Simple Equation for Magnetic Resistance.—A paper by Mr. Joubin is mentioned briefly in the Lond. "Elec.," June 22; he transforms Van der Waal's well known formula for the density and pressure of gas into corresponding quantities in magnetic terminology and arrives at Froelich's formula; as there is an abrupt change in the curve for a fluid when the vapor tension becomes zero and a change of state occurs, so there is an abrupt change in the magnetic curve at saturation, and it is the intention of the author to investigate this point in order to obtain, if possible, a simple fundamental equation for the magnetic resistance.

Intense Magnetic Field.—The magnet for producing the most intense field that has been generated, mentioned in the Digest June 30, is illustrated in "L'Ind. Elec.," June 10.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Finding Faults in Coils.—The following method is described by Mr. Campbell in the Lond. "Elec.," June 22; it applies more particularly when the fault between some unknown part of the coil and its bobbin has a variable resistance. A high resistance galvanometer is connected with the bobbin, and with first one and then the other of the free ends of the coil another coil is wound around the coil to be tested and is used as a primary through which a battery current is made to pass, the faulty coil acting as the secondary; the throw of the galvanometer is observed first for one terminal and then for the other, the number of turns up to the fault is then proportional to these two deflections, from which the fault is then localized. If the resistance of the fault is variable the galvanometer resistance ought to be high as compared with it; a ballistic galvanometer should be used if possible; if not sensitive enough, an iron core should be inserted and should preferably be laminated; this will also make the method more accurate; the primary coil may then be wound around the iron core instead of around the coil, the iron circuit being completed; an alternating current may also be used. A rough test may be made by placing a compass needle at the centre of the coil and noting the deflections when a battery is connected, first between the bobbin and one end of the coil and then between the bobbin and the other end.

Grassot Meter.—An illustrated description is given in "L'Ind. Elec.," June 10, a translation of which, together with the illustrations, is given in the Lond. "Elec. Eng.," June 15. It is extremely simple but appears to be intended only for small powers. A vertical silver wire, accurately calibrated in diameter, has its lower end resting on a glass plate, the end being immersed in a solution of nitrate of silver; a plate in the solution forms the other electrode; as the current passes, the end of the wire is consumed and a weight attached to the wire forces it down as fast as con-

sumed; a simple registering device operated by the descending wire indicates the current consumed in ampere-hours. The working potential is obtained by inserting a resistance in the lighting circuit which, for a meter of a maximum of three amperes, is equal to 0.4 ohm; a high resistance, in this case 2,750 ohms, is placed in series with the silver wire, and as this forms the greater part of the resistance, the ratio of the currents may be taken as equal to that of these resistances; the error in this meter is 6 per cent. for 0.5 amperes, 2 per cent. for 1.5 amperes and 0 for 3 amperes; these meters can be used in installations of from 1 to 6 lamps and their cost is quite small.

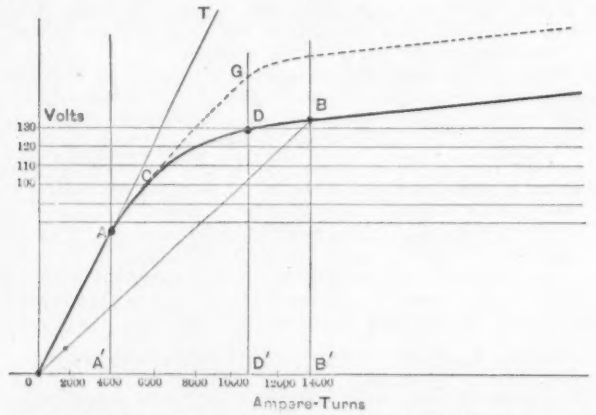
Bolometer.—The Edelmann bolometer is described and illustrated in the Lond. "Elec. Rev.," June 22; four thin blackened iron wires are stretched between suitable contact blocks, forming the four arms of a Wheatstone bridge, a resistance being inserted to bring about the balance; a difference of temperature of 0.0001° C. between two of the wires will give a deflection of 20 mm. at one meter, with a current of 0.25 ampere in the main circuit.

Lippmann Electrometer.—Mr. Bouty, in a paper read before the French Academy of Sciences, abstracted in "L'Ind. Elec." June 10, stated that the initial capacity of mercury is 140 microfarads per square centimetre after it has been in contact for some time with acidulated water, and that it decreases from that value to 28.

Spark Photographing.—An instrument for photographing falling bodies, or the splash of a drop, for instance, is briefly described and illustrated in the Lond. "Elec. Rev.," June 22.

DYNAMOS AND MOTORS.

Dynamos for Charging Accumulators.—In an article by Mr. Rechniewski in "L'Elec.," June 16, a translation of which together with the illustrations is given in the Lond. "Elec. Eng.," June 22, he describes an interesting improvement in the construction of such machines. When a dynamo is to be used for charging accumulators during the day and for direct lighting at night, it should run properly at, say, 110 volts for small loads, direct lighting, 120 volts for full load, direct lighting, and 170 volts for charging accumulators; to comply with these conditions and have the machine run in a stable manner and without sparking, is difficult; if constructed for 170 volts it will be unstable if run at 110 volts, that is, for the slightest variation in the velocity or in the output, the voltage will vary considerably; if constructed for 110 volts it is almost impossible to run without sparking at a higher voltage; the result could be accomplished by changing the speed, but this is impracticable; it could be accomplished by separate excitation from the accumulators but it will be difficult in that case to run without sparking. Referring to the adjoining figure, the tangent of the angle B O B is proportional to the resistance of the exciting circuit; this can be varied with a rheostat under the conditions that the angle is smaller than that of the tangent T O to the curve at the origin, for if larger, the machine will not be stable; for this reason the excitation cannot be reduced below the point A and preferably not below the point C; as heating would occur above an excitation of 11,000 ampere turns corresponding to 130 volts, this machine has a range of only 30 volts; if, however, from the point C the characteristic can be changed to the dotted line, a range of 50 volts can be obtained without too much heat; this is accomplished by using very small teeth on the armature, so small that they are not saturated at 100 volts, while the field and armature are then still far from saturation; the saturating of the teeth gives the first part of the characteristic, after which the teeth will act as an air space and the characteristic will again become nearly straight, but with a different inclination; the same principle can be applied to over-compounded dynamos.



DYNAMOS FOR CHARGING ACCUMULATORS.

Synchronous Alternating Current Motor.—A paper by Prof. Ferraris is abstracted in "L'Ind. Elec," June 10; it is theoretical in character and leads to a new possible combination resulting in a synchronous alternating motor with an alternating field, the possibilities of which have as yet not been pointed out by any one; the theory is promised in a subsequent article. In a simple alternating current motor with a constant field, imagine that the field in which the armature turns, instead of being constant is alternating, and has the same frequency as the current traversing the armature; it is easily shown that in this case the machine can act as a dynamo or as a synchronous motor, the armature revolving at an angular velocity equal to double the frequency; it is thus possible to construct a synchronous alternating motor with an alternating field; such a motor may be started by using temporarily a di-phase current until synchronous speed is obtained, by means similar to those suggested by Mr. Brown.

A translation from the Italian of an article by Mr. Arno is published in the Lond. "Elec. Rev.," June 22; he gives a very complete table of 13 columns of data, the results of 14 tests of a 15 h. p. single phase synchronous motor of the Brown type, for 150 volts, 800 revolutions, 40 periods and weighing 1200 lbs.; curves for some of the principal measurements are also given; the first test was when the motor was at rest, thus giving the starting torque, the second when it was running at full speed but unloaded, and the others when loaded up to full load; the results do not admit of being abstracted; when delivering 0.78 h. p. the efficiency was 0.49 and when it gave 15.47 h. p. the efficiency was 0.82; the highest efficiency, 0.88, was obtained when running at 9 to 14 effective h. p.; the force on the lever arm of the brake while at rest is about 1-7 that when it ran at its normal load.

See also abstract under "Diphase Transmission of Power."

ARC AND INCANDESCENT LIGHTS.

Gas vs. Electricity.—In an inaugural address by the president of a Gas Institute, published in the Lond. "Elec. Eng.," June 22, an argument is given in favor of using gas and it is claimed that light from gas can be produced from 3 to 3½ per cent. cheaper than the price for which the equivalent electric light can be sold so as to produce the same profit that is being derived from the manufacture of gas.

The same journal contains the first part of a paper by Mr. Chew, read before a gas institute, which is very elementary in character and argues in favor of gas for the city of Blackpool. See also abstract under "Electric Light from Gas Engines."

Incandescent Gas Burners.—A report from the German by Mr. Muerchall is referred to editorially in the Lond. "Elec.," June 22; his experience is based on 37 to 471 burners; he thinks the mantels are strong enough to withstand the natural shocks; 60 c. p. can be obtained from 3.5 cu. ft. of gas per hour; the chimneys, costing 6 cts., have to be renewed about every 600 hours, and the mantles, costing 6 cts., every 500 hours, during which time they lose 4 per cent. in candle-power.

TRANSMISSION OF POWER.

Diphase Transmission of Power.—A very full description, together with a large number of illustrations, of a plant at the Decize collieries in France is given in "L'Ind. Elec.," June 10; a brief abstract is given in the Lond. "Elec." and Lond. "Elec. Eng.," June 22, but without illustrations. The generating station is over three miles from one of the extreme points and almost two miles from the other, and has a capacity of 200 kilowatts, the generators consisting of a sort of twin alternator; the current is transmitted almost entirely on overhead wires. The motors have the stationary parts like the dynamos of the same power, but with double the number of poles; for those of 30 h. p., the illustrations of which are given, the number of poles is 16, that is, 8 for each circuit connected in series; the induction in the cores is 4.5 kilogausses; the currents create a rotating field of a velocity of 630 revolutions per minute; the moving armature has a hollow cylinder as core, carrying tangential coils in grooves; for normal running the armature is short-circuited; for starting, the two currents are led out through sliding contacts to two resistances, consisting of metallic plates immersed in a solution of sulphate of copper. When not loaded the speed is only 1 per cent. below that of synchronism, for half the charge it is 2.5 per cent. and for full charge from 5 to 6 per cent.; the induced currents in the armature represent almost the entire work corresponding to this loss of velocity; the efficiency is 80 per cent. at half charge and 88 per cent. at full charge; the motors require attention only once in 6 or 8 hours.

ELECTRIC RAILWAYS.

Gas Power Traction.—The Lond. "Elec.," June 22, refers editorially to recent experiments in Croydon. The car contains three cylindrical gas holders with a sufficient supply for an 8-mile run; the car is 18 ft. long, and weighs, with machinery, 5½ tons; an Otto motor, constructed specially for tramway work with slow and quick speed, is used; the ignition is effected electrically, and a condenser is used; an 8 h. p. gas engine at the station compresses the gas taken from the city mains into the cylinders, this power being sufficient for 5 cars; the pressure in the cylinders is about 20 lbs. per sq. in. at starting, and the cost of the gas is said to be 2 cts. per mile, run with a fully loaded car. It is thought that the capital per horse-power is relatively greater than for electric traction, and that the starting effort is more disadvantageous for gas motors than for electric motors; also that the cooling of the cylinders must involve some difficulties.

Tramways in Germany.—An itemized estimate of costs of a small horse car line and an electric line in Germany is given in the Lond. "Elec.," June 22; the total cost of the former is about $37,000 for a length of about 8 miles, and the cost of operation 5.44 cts. per car mile; while for the latter the figures are about $56,000 and 3.44 cts.

Hamburg Tramway.—An illustrated description of this road, equipped by the Thomson-Houston Company, is published in the Lond. "Elec. Rev.," June 22.

Lyons.—The illustrated description of this trolley line is concluded in "L'Elec.," June 9 and 16; a number of details are illustrated.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Electric Light Gas Engines.—In an article by Mr. de Segundo, in the Lond. "Elec. Rev.," June 22, he shows the great economy in using gas engines for generating current for lighting, giving all the details in his estimates, and making due allowance for all losses; he finds that 33.3 cu. ft. of gas correspond to the production of one kilowatt-hour, which, however, is not likely to be realized continually in practice; on the basis of 2.5 watts per candle of an incandescent lamp, he shows that 1,000 cu. ft. consumed per hour in a gas engine corresponds to 10,000 candle-hours, while if burnt in a gas burner at the rate of 5 cu. ft. per hour, per 16 candles, it will yield only 3,200 candle-power-hours, thus showing a very considerably greater efficiency in the transformation of gas into light by means of gas engines. He quotes at some length from an article by Mr. Bourquien, published in "La Lum. Elec.," Jan. 13-20 (see Digest, Feb. 10, 17, and March 3) on the basis of 18 cu. ft. per brake h. p. per hour in large engines, he obtains 13,200 candle-hours electrically and 3,200 when burned in burners, showing a ratio of 4.125, from which he concludes that it is not unreasonable to say that it is practically possible to get four times the illumination per cubic foot from a gas engine, and using it for electric lights; he shows that in a very large station the saving in fuel would be nearly 200 tons of coal per annum. A similar comparison is made between arc lamps and high candle-power gas burners; for the former he assumes one watt per effective candle, and for the latter 6.71 candles per cu. ft. per hour in the Wenham gas burner, in which case also a very marked economy is shown in favor of the arc lamps. In referring to the article by Mr. Bourquin, he mentions the equation from which the equivalent number of arc and Wenham lamps for equal total cost can be calculated; he works out some figures and shows that, for instance, if a building requires more light than from 24 Wenham lamps of 130 candle-power each, it is cheaper to put down a gas engine plant and run arc lamps, than to use gas lamps, a result which he thinks should be accepted with much reserve, as the limit of candle-power, he thinks, is too low.

The Lond. "Elec. Eng.," June 22, contains a translation of an article by Mr. Wizt, given somewhat more fully in "L'Ind. Elec.," June 10, on the price of energy supplied by gas engines; with gas at three cents per cu. m. the annual price of 150,000 lamp-hours, with 15 c. p. lamps, is 1.06 cents per hectowatt-hour, for 450,000 it is .836 cent and for 1,500,000 it is .704 cent; these figures are based on balance sheets, in which provision has been made for interest and redemption at 15 per cent., but without allowing any profit; the expenses, however, are reduced, because the leads are short, it being proposed to erect stations consisting of a dynamo and a gas engine in the immediate neighborhood of a small collection of houses; for a group of 1,000 lamps requiring 65 kilowatts, he gives the detailed estimate of the cost of installation and the cost of running for a total of 97,500 kilowatt-hours, the results being an initial cost of $13 per lamp and 7 cents as the cost per kilowatt-hour or 0.5 cent per 16 c. p. lamp-hour.

Refuse Destructors.—In an editorial in the Lond. "Elec. Rev.," June 22, a paper by Mr. Baker is referred to; from his experiments he concludes that one pound of "breeze" sifted from the Paddington refuse will evaporate 21½ lbs. of water; the average consumption was six tons of breeze and one ton of coal, costing $10.50, which did the work of three tons of coal costing $15.75; he places no reliance on refuse used alone, nor does he favor its use unsifted; in order to obtain a red heat temperature he introduces an additional furnace burning some high class fuel; of a total of 100 tons of refuse, 70 disappeared in the furnace, being probably mostly water.

In a communication to the Lond. "Elec. Eng.," June 22, by Mr. Silcock, it is concluded that however successful the system of storage of power may be, there is not even sufficient power in the refuse of a town for public lighting alone, without considering the question of private lighting; a few figures are given to prove this.

Central Stations in Germany.—"L'Ind. Elec.," June 10, publishes at some length, including large double page tables, the results given in the German articles referred to in the Digest, June 2, 16 and 23.

Brussels.—A description of this station, with a few illustrations, is begun in "L'Elec.," June 16.

Glasgow.—The discussion of Mr. Arnot's paper on this station is given in the Lond. "Elec. Eng.," June 22.

WIRES, WIRING AND CONDUITS.

Cable for Ships.—At the Royal Society Exhibition Mr. Wimshurst showed a swivel for avoiding the kinks in cables attached to lightships; it consists essentially of two coils which are capable of turning on a common axis, mechanically connected but electrically disconnected, by means of which the current is transmitted over the swivel joint by induction.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Duplex.—Another communication in the discussion which has been going on in the Lond. "Elec. Rev." is published in the issue of June 22.

Telegraph between India and Europe.—A short article on the reduced rate of such telegraph is published in the Lond. "Elec. Rev.," June 22.

Pacific Cable.—Several other letters are published in the Lond. "Elec. Rev.," June 15. The Lond. "Elec. Eng.," June 22, contains an editorial on this subject.

ELECTRO-CHEMISTRY.

Primary Battery for Lighting.—The Lond. "Elec. Rev.," June 22, mentions but does not describe a new battery which has been used with some success in England; it is called the "Fulgur" and is an improved form of Daniel's cell; the chief improvement in the cell is in the septum, which consist of a preparation of cork somewhat resembling a certain floor cloth; the installation consisted of 50 lamps of 10 c.p. A storage battery is used and is divided into six sets, which are charged four hours at a time, one after the other in succession, once in 24 hours, the connections being made by an automatic switch operated by a clock; proper circulation of the fluids and the supply of copper sulphate and water are provided for; no figures regarding costs are given.

MISCELLANEOUS.

Resuscitation after Electric Shocks.—Some weeks ago an article was abstracted in these columns stating that Dr. d'Arsonval claims that a man apparently killed by an electric shock should be treated like one who has been drowned; in an article by that author in the Lond. "Elec. Rev.," June 22, 'L'Ind. Elec.," June 10 and 'L'Elec.," June 9," this is modified by the statement that he had shown in 1887 that electricity occasions death in two very different manners: by lesion or destruction of the tissues (disruptive and electrolytic effects of the charge) or by excitement of the nerve centres, producing the arrest of respiration and syncope, but without material injuries; in the former case death is final, while in the latter it is merely apparent, and it is then possible to resuscitate the victim by artificial respiration, as in drowning; he claims that the alternating currents used in the execution of criminals in New York State produce nearly always the second kind of death.

Electric Cooking.—In an editorial in the Lond. "Elec.," June 22, it is suggested that instead of using an expensive kettle or an inefficient hot plate, an ordinary kettle could be used with an apparatus called a boiling stick, which is simply placed in the water to be heated, like a red hot poker; a silver tube with double walls containing a resistance of about 14 ohms ought to boil a pint of water in five minutes.

Sonometer.—At the Royal Society Exhibition Mr. Hawksley showed an instrument for measuring the acuteness of hearing, based on a note produced in a telephone by means of a make and break current in a sort of transformer in which the primary may be moved relatively to the secondary, the distance between the coils at which the sound appears to cease being a measure of the acuteness of hearing.

New Book.

ELECTRICITY ONE HUNDRED YEARS AGO AND TO-DAY. With Copious Notes and Extracts. By Edwin J. Houston, Ph. D. (Princeton). New York: The W. J. Johnston Company, Ltd. 199 pages, illustrated. Price $1.00.

Professor Dolbear in a recent address referred to the prevalent saying "Electricity is in its infancy" in the following words: "Electricity is not in its infancy. Despite what has been done, there is nothing in the present use of electricity but what has been known for many years. Arc lights were known eighty years ago; the telegraph is sixty years old, the telephone thirty, and the incandescent lamp ditto. We are not at work with new things or on new principles. If you are running a motor with electricity, it is not a new discovery in electricity to apply the same power to the operation of a lathe or a street car." At the present time, when the belief is so widespread that electrical science has sprung up in a day, it is convenient to have at hand an historical resume to check the many statements made to this effect, and the work by Prof. Houston serves this purpose admirably, besides being a most agreeably written book for general reading.

In tracing the history of electrical science from practically its birth to the present day, the author states he has, wherever possible, consulted original sources of information, and he was fortunate in having at his disposal for this purpose the excellent library of the Franklin Institute, containing, as it does, perhaps the most complete collection of scientific publications of the last century to be found in this country.

As a result of these researches, several revisions as to the date of discovery of some important principles in electrical science are made necessary. For example, Prof. Houston finds that Sir Humphrey Davy was anticipated in the discovery of the electric arc by many others, and in fact did not claim to have been the first discoverer of the brilliant effects of the arc. Proper credit is given to Gilbert for his inductive methods and in an appendix several writers are quoted to show that Bacon has been honored above his merit in this respect.

While, as the author states, the compass of the book does not permit of any other than a general treatment of the subject, yet numerous references are given in foot notes, which also in many cases quote the words in which a discovery was first announced to the world, or give more specific information in regard to the subjects mentioned in the main portion of the book. This feature is one of interest and value, for often a clearer idea may be obtained from the words of a discoverer of a phenomenon or principle than is possible through other sources.

An examination shows that the work is not a mere catalogue of subjects and dates, nor is it couched in technical language that only appeals to a few. On the contrary, one of its most admirable features is the agreeable style in which the work is written, its philosophical discussion as to the cause and effect of various discoveries, and its personal references to great names in electrical science. Much information as to electrical phenomena may also be obtained from the book, as the author does not seem to be satisfied to merely give the history of a discovery, but also adds a concise and clear explanation of it.

NOTES.

The Buyers' Reference has appeared, in its issue for the second quarter of 1894, in a new form. The size has been sufficiently enlarged to include

a tinted column running through the book, which contains an alphabetical classified list of manufacturers of all apparatus, machineries and supplies used by the electrical street railway and allied industries. The typographical excellence of the publication continues to be maintained.

Portable Electric Deck Planer.

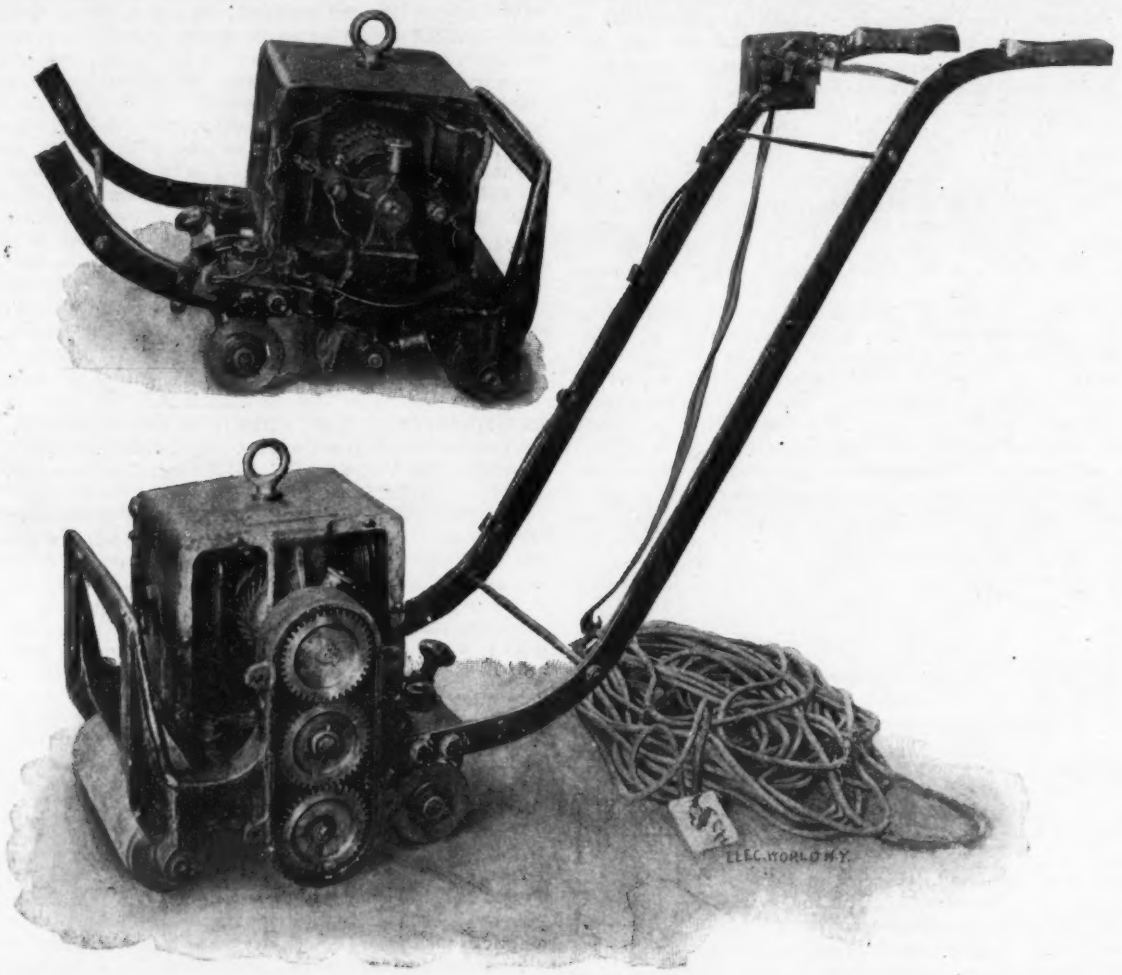
BY CHAS. J. DOUGHERTY.

The portable electric deck planer mentioned recently in an article on "Electricity at Cramp's Shipyard" and herewith illustrated, was imported from London by The Wm. Cramp & Sons Ship and Engine Building Co., of Philadelphia, to plane the decks of men-of-war and transatlantic steamers now in course of construction at their yard. Being a novelty, it has created quite a little curiosity among the workmen and visitors, and at present is in use planing the decks of the Government cruiser Minneapolis. It was manufactured by Mavor & Coulson, Glasgow, after Sayer's patent.

The motor rests upon a strong rectangular cast-iron frame, supported on the front end by a solid cylindrical roller 3¼ inches in diameter, and at the far end by the 4-inch wheels connected by a ¾-inch shaft. The motor is bolted down to this frame, and its weight with that of the roller is sufficient to give the machine a solid bearing surface upon the deck. The motor is series wound, of the iron-clad type; the fields and armature are incased in a ¾-inch solid casting, in the top or which is screwed a 2-inch eye bolt to facilitate the handling of the heavy machine from place to place. It is designed for twenty amperes at 100 volts and has a speed of 3,000 revolutions per minute. The commutator consists of twenty segments and the armature is of the drum type. Copper gauze brushes were used on the commutator at first, but owing to the rapid wearing of the copper, causing the circuit to open at the brushes and throwing the machine out of commission by necessitating the removal of the covering at the commutator end, solid carbon brushes were substituted, and have given perfect satisfaction.

The motion of the armature shaft is transmitted through a train of three gears, without any reduction, to the shaft, upon which are mounted the knives, and located immediately under the armature. There are two knives bolted to this shaft, set at 90 degrees apart. The cut of the knives is regulated by the rear wheels, which support the frame of the machine, and the shaft connecting these wheels is raised or lowered in the cast-iron frame by the action of an eccentric, whose throw is 3-16 of an inch, and operated by a small lever, as seen in the illustration, at the back of the motor. This lever moves in a slotted arc and is made stationary for any desired depth of cut by means of a thumb screw attached to the lever. The handles for propelling the machine are bolted directly to the frame. The ¼-inch rods hold the handles in position, and attached to the upper part of the right hand handle is placed the single pole knife switch mounted upon a small slate block. Brass couplings are also on this block for attaching the conducting wires, which consist of the lengths of flexible hemp cable about 100 feet long to allow sufficient run for the machine.

An ordinary rosette with fuse is attached to the cable, and the power is given to the motor by attaching the rosette to any of the temporary wires supplying current to the incandescent lamps throughout the ship. From the block two 8-stranded wires conduct the current to the motor, and are held in place by five brass clips secured into the frame handle and insulated from the same by hard fibre. A square brass box is fitted over the slate block at the handle and offers a protection from injury to the wires or switch. The motor is entirely incased when in use, although the illustrations do not show it, so that it is impossible for shavings or dust to touch the commutator or interfere with the machine. The wooden handles made to fit over the iron have been introduced to protect the operator's hand from soreness consequent from constantly pressing against the planer when working.



Electric Deck Planer.

Very little power is required to propel the machine over the deck; the operator by pressing the lever at the handle closes the switch, the motor starts, the knives in turn revolve, and pushing the planer along by hand the sharp steel knives plane down the rough deck to the smoothness of a ball room floor. The machine can do the work of fifty men in one day, and while it may seem on this account that it should be considered an enemy by the workingmen, on the contrary, its coming was heralded with delight, for the hardest and most tedious part of ship joiner work is the planing down of decks by hand.

Ignorance of American Practice.

In a recent preliminary report made for the city of Newcastle, England, the cable system was recommended as preferable to electricity, on the grounds that there was difficulty in "applying any electric system to towns where there are hills to surmount." The engineer, Mr. Laws, who made this statement, and who appears to be a mechanical, and not an electrical engineer, has evidently never seen nor heard of the electric lines in this country. We would suggest that he take advantage of the first opportunity to inspect the electric railways of the United States.

A New Switch.

BY P. E. MARCHAND.

It is sometimes desired to have three or four switches to control the same light or group of lights from different points. Having had to work out the case of three independent switches on a hall light some time ago, and seeing no multiple switches advertised except the three-way switch, which only covers two points, I made the following switch, which works in series with the ordinary three-way switches, and allows

FIG. 1.— NEW SWITCH.

of any number of switches to be used independently on the same light or group: *a* and *b* are ordinary three-way switches, *c* and *d* are the two wires running between them, and, as shown in the diagram, these two wires enter into every intermediate switch, so that there are four terminals in each of the latter; *e*, *e*, *e*, *e*, are four binding posts, to which wires are attached, as shown, and carrying at their base double

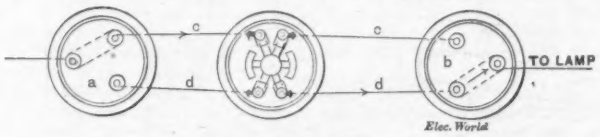


FIG. 2.— NEW SWITCH.

contact pieces, between which the arms, *f*, *f*, *i*, *i*, and *h*, *h*, slide alternately; *f*, *f*, and *i* are insulated from one another and from the hub, to which they are firmly secured; *g*, *g* is also firmly secured to the hub and carries at its ends well insulated sectors, *h*, *h*.

The action of the switch is through one-quarter of a turn, either way; as will be seen by the diagram, one motion transposes the line and the other straightens it, so that on whatever contact the three-way switches may be, a single motion of these intermediate switches will either turn the light on or off.

Electromagnetic Turbine Supporter.

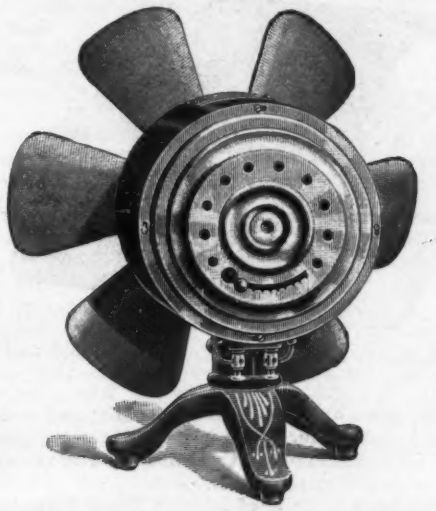
Turbines used for driving dynamos are frequently constructed with a vertical shaft, the armature moving in a horizontal plane; in such aa arrangement the pressure due to the weight of the turbine shaft and the greater part of the dynamo must be taken upon some part of the rotating

TURBINE SUPPORTER.

shaft; this is sometimes accomplished, as in the Niagara Falls plant, by supporting this weight on a water column pressing upward near the bottom of the turbine shaft, but with very great weights and small falls this arrangement is not always practicable. Furthermore, it depends on the height of the water column, is not capable of regulation, and as it involves the construction of the turbine it cannot be applied to existing installations. To overcome this, the Oerlikon Company, of Switzerland, has constructed a very simple apparatus, of which they have sent us a description. It consists essentially of an electro-magnet, as shown in the adjoining figure, made of one coil and a circle of alternate poles; this encircles the shaft and is firmly supported from the lower part of a suitable foundation; the shaft has fastened to it the armature in the form of a ring made of laminated iron consisting of a coil made of a band of iron; the attraction of this electromagnet for the armature is adjusted so as to relieve the bearings of the vertical pressure due to the weight. It can be constructed to support a weight of 110,000 lbs. The largest at present constructed is for about 30,000 lbs., and is in use at the installation of the Rhone Land and Water Power Company, Bellegarde, France. The power consumed is about one-third horse-power per ton pull, which is small as compared with the energy otherwise lost in an end bearing. It will readily be seen that such an apparatus is independent of the power, speed, water pressure, etc., and is readily adjustable by a resistance inserted in the circuit of the coil. The pull exerted by the magnet on the armature is about 42.6 lbs. per square inch. An apparatus for 12 to 14 tons requires about 20 amperes at 80 volts.

Fan Motors.

The fan we illustrate, manufactured by the Wagner Electric Mfg. Company, St. Louis, Mo., is designed for both direct and alternating currents, and embodies the result of the improvements which three years of manufacture and service have suggested. The motors have self-feeding carbon brushes, which will run a season without renewing, and self-oiling bearings, which hold an ample supply of oil for several months' run. All motors are adjustable in speed by means of a button



WAGNER FAN MOTOR.

conveniently placed. They are finished in black enamel with gilt trimmings, and have a polished brass fan and end caps. These brass end caps entirely inclose the ends of the motor, protecting the armature, commutator and bearings from dust and dirt. They are fastened to the motor frame by a simple bayonet joint, requiring a slight twist only to disengage them entirely, without the aid of screw-driver or wrench. When removed they in no way interfere with the running of the motor, and the brushes and oil caps may be examined under normal running conditions. The weight and spread of legs make any fastening unnecessary, and rubber feet effectually prevent noise and vibration.

Iron Armored Insulating Conduits.

The notable tendency in architecture of late years has been toward the use of the most substantial materials obtainable, and in keeping with steel internal structure is the iron conduit system for wiring; by its means electric wiring, whether in the main conductors or in the smallest branches, has been brought to a most satisfactory state of efficiency. Herewith we illustrate some of the material used for this purpose, which

FIG. 1—IRON ARMORED INSULATING CONDUIT.

is manufactured by the Interior Conduit and Insulation Company, 44 Broad street, New York, the pioneer with insulated iron-armored conduit, as it was in the use of brass-armored conduit.

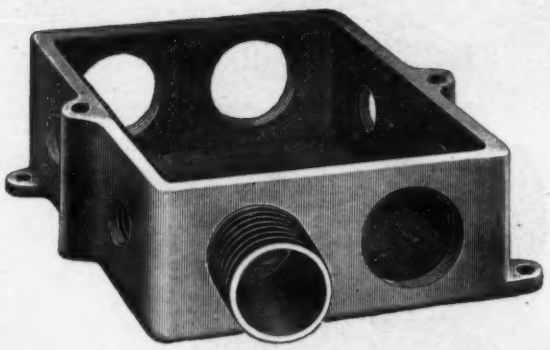
The tubing consists essentially of plain insulating Interior Conduit tubing placed within a heavy wall of lap-seamed, wrought iron pipe, which thus furnishes an armor ⅛ in. in thickness. The union between the

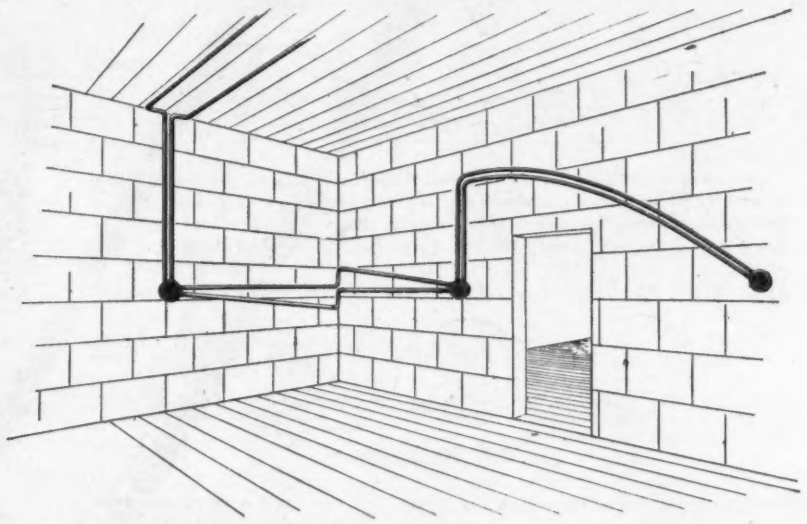
inner tube and its iron wall is firmly consolidated and welded together, and yet each is integral, the outer for protection from mechanical injury and the inner for electric insulation.

The flexibility of the system is maintained by the use of iron armored

FIG. 2.—IRON ARMORED INSULATING CONDUIT.

insulating junction boxes, elbows, couplings, etc. The conduit possesses the qualities of gas or water pipe, and by means of the tools furnished for cutting, threading, etc., can be installed with equal ease. It can be used under concrete, tiled or mosaic floors, etc., without the precautions





FIGS. 3 AND 4.—IRON ARMORED INSULATING CONDUIT.

necessary with plain or brass-armored conduit; and at the same time a great saving in labor is due to the fact that it can be installed at an early stage in the construction of a new building, without anxiety as to the rough usage it may have to sustain.

Fig. 1 shows the actual size of 3-8 inch (inside diameter) iron conduit. Fig. 2 shows an ordinary and continuous insulating nipple, with the application of the latter to a junction box, illustrating how the continuity of the insulating system may be maintained if the tube should be too short by inaccuracy of measurement. Fig. 3 is a junction box; Fig. 4 illustrates the flexibility of the system and shows corner elbows and outlet boxes.

Electric Elevated Railroad in Chicago.

The West Side Elevated Railroad of Chicago is to be operated entirely by electricity. Influenced by the success of the Intramural electric railway at the World's Fair, which transported during the short time the Exposition was opened not less than 5,803,895 passengers, without a single accident and without any serious stoppage, and has proved an agitating leaven in the minds of the steam railroad men, only wedded to their steam power until a more economical system can be found, and after careful and thorough investigation of every possible system of passenger car propulsion, the president and directors of the West Side road decided that electricity was the most economical system. The generators and motors are already under construction in the Schenectady shops of the General Electric Company, where those for the Baltimore and Ohio Railroad Company are also nearing completion.

The company operating this road is the Metropolitan Elevated Railway of Chicago, the president of which is Mr. R. Summers Heyes, President of the St. Paul and Duluth Railroad, Chairman of the Reorganization Committee of the Atchison, Topeka & Santa Fe road and Director of the Metropolitan Traction Company, New York. The West Side Road, which connects that part of Chicago with the main city transit system, is to be a four track road for a greater part of the way, to allow of an express service. The line will cross the river on a four track way laid upon a drawbridge.

The power is to be generated by four dynamos. Two of these are to be of 2,000 h. p. each, and will be counterparts of the huge machine which ran in the Intramural power house during the Fair. This, at that time, was the largest ever built, but since these four have been installed in Brooklyn, N. Y., and three in Philadelphia, Pa. The two smaller dynamos are to be of 1,000 h. p.

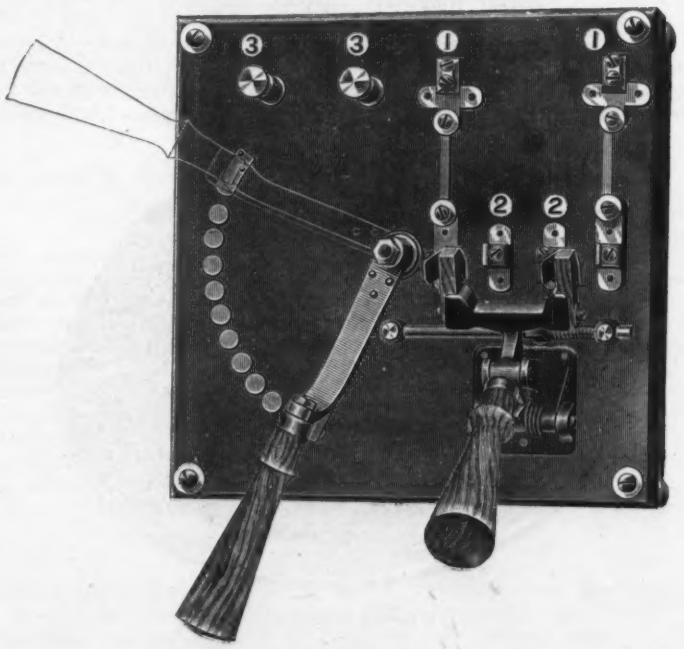
The current will be carried from the power house over the line by means of a "third rail" placed at the outside of each service track. A sliding shoe contact, hanging from the truck of each motor car, will take up the necessary current for the motor.

The first order covers fifty-five complete equipments, to comprise at first two powerful motors with the necessary controlling apparatus, and electrical air pump for the air brake, and the subsidiary apparatus and appliances. The motors will be to a great extent similar to those used at the Exposition. Two motors only to each motor car are to be used at present, but eventually two additional motors will be placed on each motor car. With the two motor cars four car trains will be run during the crowded hours of the morning and evening, and three car trains during the hours of slack travel, at a speed of thirteen miles an hour, including stops. With the four motor cars the trains will consist of six cars and the speed will be increased to fifteen miles an hour.

According to the present indications, the electric cars should be running on the elevated by the middle of November next.

Combined Switch and Rheostat.

In installing motors the switch and rheostat are generally placed side by side, and being entirely separate from each other, it oftentimes happens that through haste or carelessness the current is thrown on by the switch before the resistance is cut in by the rheostat, and as a consequence the motor armature is burned out or the fuses blown. The W. S. Hill Electric Co., of Boston, Mass., have placed on the market a self-locking starting switch, which we illustrate, in which the switch and



COMBINED SWITCH AND RHEOSTAT.

rheostat are combined, as shown, in such a manner that the former cannot be thrown in without first putting in all of the resistance, thus obviating accidents of this kind. An additional advantage is that the cost of the combination is less than that of a switch and rheostat separate.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, July 7, 1894.

THE ELECTRICAL STOCK MARKET'S course these days is governed by much the same causes that bring about the dullness at present characterizing all speculative markets. Just in the same way, though, electrical stocks, like the whole stock market, betray an inherent strength that has much of promise in it in the way of improving quotations. The whole situation is governed by the strike news, the uncertainty attending the fate of tariff legislation, the gold export question, etc., and until these disturbing influences are so far removed as to leave commerce uninterrupted, electrical stocks must continue to reflect the dearth of business by remaining inactive.

GENERAL ELECTRIC has displayed great strength within the last day or two. On Friday especially, there was good buying to the stock, purchases in many instances being directly traceable to insiders. There is an influential bull pool at work, but they have not been doing anything of late by reason of the inactivity in the stock market. But with the first signs of revival General Electric will be found to be a leader in the spurt toward higher quotations. It is well known that the business of the company has picked up a good deal of late. In addition to securing the contract for equipping the Metropolitan Elevated Railroad of Chicago, the company announced this week that it has closed a contract with the West Side Electric Railway of Chicago, to equip its entire line with electricity on a principle similar to that employed last year on the Intramural Railway at the World's Fair. The contract price is understood to be a little over $300,000, and was awarded to the General Electric Company after spirited bidding with the Westinghouse Electric & Manufacturing Company, of Pittsburg; the Siemens & Holske Electric Company, of Chicago; the Walker Manufacturing Company, of Cleveland, and the Electric Construction Company, of London, Eng. Boston advices are that these two large contracts are only samples of the company's enterprise. It is said to be now doing more than $10,000,000 gross manufacturing business per annum, and, if there is 20 per cent. profit in this—and there ought to be—the accumulation of a surplus for distribution among stockholders does not seem very far distant. The railroad business for May was the largest month's business in the history of the company, and June's total is likely to eclipse even May's big record. The shops at Schenectady have already begun work on the Metropolitan Elevated contract, and the force will now be increased to take up the West Side job. There are hints in many quarters that much of the new business is taken at a loss, but most of the derogatory rumors concerning General Electric now afloat are directly traceable to disgruntled bear sources.

THE STREET RAILWAY AND ILLUMINATING PROEPRTIES' trustees knew what they were about when they bought last year some $12,000,000 General Electric treasury assets for one-third their face value. They managed to have enough money on hand this week from interest and dividend payments on their holdings to buy in 456 additional shares of the preferred stock, paying $98.48 per share. This makes a total of 11,943 preferred shares cancelled to date, while another $60,000 have been set aside to buy in more on July 11. The assets of the trust are certainly good, and had the General Electric been allowed to retain them there would be no occasion for the necessity of capital reduction or the talk of reorganization.

WESTINGHOUSE ELECTRIC issues have been unsually quiet since the determination of the Board of Directors not to make any distribution of profits among common stock holders at this juncture. Quotations have fluctuated only fractionally, and hardly any interest has been manifested either in the preferred or common shares. Official statements as to business conditions continue encouraging, as entire satisfaction with the situation and prospects is expressed. The new works at Brinton, near Pittsburg, are being hurried to completion, and the installation in the fall of the new factory plant means an era of increased prosperity.

THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY'S stockholders, in pursuance of a call signed by Directors John E. Hudson, James D. Davis, Edward J. Hall, W. D. Sargent and John Jameson, held a special meeting in this city yesterday "for the purpose of voting upon a proposition to increase the capital stock of said company to $12,000,000, consisting of 120,000 shares of the par value of $100 each." The officers of the company declined to divulge the business accomplished at the meeting.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York	50	10	30
Cleveland General Electric Co.	100	80	90
Detroit Electrical Works	10	3	4
East River Electric Light Co.	100	—	50
* Edison Electric Ill., New York	100	100	100½
* " " " Brooklyn	100	101	102
" " " Boston	100	116	115
" " " Chicago	100	135	145
* " " " Philadelphia	100	128	130
Edison Electric Light of Europe	100	1	3
Edison Ore Milling	100	10	15
Electric Construction & Supply Co., com	15	15	17½
" " " " " pref.	15	15	17½
Fort Wayne Electric	100	1	2
General Electric	100	36¼	36½
Interior Conduit & Ins. Co.	100	45	55
Mount Morris Electric	100	25	50
Westinghouse Consolidated, com.	50	35	36
" " pref.	50	50½	51½

BONDS.

Edison Electric Ill., New York	1,000	106½	107
Edison Electric Light of Europe	194	75	85
General Electric Co., deb. 5's	1,000	86¼	86½

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	195	196
American District Telegraph	100	—	45
American Telegraph & Cable	100	88	89
Central & South American Telegraph	100	105	110
Commercial Cables	100	125	—
Gold & Stock Telegraph	100	102	104
* Mexican Telegraph	100	190	200
* Western Union Telegraph	100	83⅛	83⅝

* Ex. div.

THE INTERIOR CONDUIT AND INSULATION COMPANY'S Board of Directors, in declaring the 5 per cent. scrip dividend, touched on in these colums last week, pointed out that the net earnings that have accumulated for the past three years are now, after charging off to profit and loss account some $38,000 arising from expenditures for experimental purposes, hitherto carried as an asset, in excess of $100,000, represented by bills receivable, material and manufactured goods on hand. Pending the conversion of the scrip into fully paid capital stock, when an increase of capital stock has been provided for, the scrip possesses, so far as legal, all the qualities of stock and is entitled to all such dividends and privileges as may hereafter be declared upon the outstanding capital stock. It is further provided that the scrip shall be converted into stock before the declaration of the first cash dividend. The dividend was made payable in scrip instead of cash because the directors deemed it "sound policy to keep the company in strong financial condition by retaining its earnings in the form of quick available assets, instead of distributing any part in cash at this time."

BELL TELEPHONE is to have its $50,000,000 capital after all, Governor Greenhalge having signed a new bill permitting the company to sell $30,000,000 new stock at auction. Naturally stockholders who anticipated getting the new stock at par are somewhat disgruntled, and are expressing their disappointment by selling stock bought some weeks ago. There is a strong movement in favor of bringing the company to this State, where there is no statute preventing the issue of new capital at par, when the market price is higher, and the agitation in favor of removal may lead to something definite. It is charged that the lobbying and other expenses attending the recent legislation cost the Bell Telephone Company over $250,000.

NEW INCORPORATIONS.

THE HERCULES ELECTRIC POWER COMPANY, Salt Lake City, Utah, has been incorporated.

THE CEBOLLA RAILWAY COMPANY, Denver, Col., capital stock $100,000, has been incorporated.

THE FANNER ELECTRIC COMPANY, St. Louis, Mo., capital stock $60,000, has been incorporated.

THE UNION TELEPHONE COMPANY, Plum City, Wis., capital stock $250, has been incorporated.

THE JOHNSON ELECTRIC SERVICE COMPANY, Milwaukee, Wis., capital stock $150,000, has been incorporated.

THE HUMPHREY MANUFACTURING & PLATING COMPANY, Kalamazoo, Mich., capital stock $15,000, has been incorporated.

THE AMBLER ELECTRIC RAILWAY COMPANY, Reading, Pa., capital stock $12,000, has been incorporated by W. B. Krick and others.

THE EMMONS ELECTRIC COMPANY, Chicago, Ill., capital stock $15,000, has been incorporated by Charles P. Emmons and others.

THE OTTAWA MUTUAL TELEPHONE COMPANY, Ottawa, Ill., capital stock $15,000, has been incorporated by C. H. Hamilton and W. F. Heath.

THE GAS, HEAT AND POWER COMPANY, Mechanicsburg, Pa., capital stock $50,000, has been incorporated by Amos Z. Meyers and others.

THE WESTERVILLE & WORTHINGTON STREET RAILWAY COMPANY, Columbus, O., has been incorporated with a capital stock of $35,000.

THE COUNCIL BLUFFS & LAKE MANAWA ELECTRIC RAILWAY COMPANY, Council Bluffs, Ia., capital stock $40,000, has been incorporated.

THE NORTHWESTERN MILLING & POWER COMPANY, Spokane, Wash., capital stock $750,000, has been incorporated for operating mills, electric lines, etc.

THE MOMENCE ELECTRIC BELL STORAGE COMPANY, Momence, Ill., capital stock $15,000, has been incorporated by C. H. Lettigh, Lincoln Walker and Frank E. Lane.

THE ELECTRIC BOILER COMPANY, Rochester, N. Y., capital stock $50,000, has been incorporated by J. Henry Howe and others, to manufacture boilers and steam heating apparatus.

THE FREDERICKTOWN ELECTRICAL AND MANUFACTURING COMPANY, Fredericktown, Md., capital stock, $6,000, has been incorporated and will erect an electric light and power plant.

THE DARRIETT ELECTRIC MOTOR & DYNAMO COMPANY, New York, capital stock $20,000, has been incorporated by J. R. Anderson, of Montclair, N. J., and others, to manufacture electric dynamos and motors.

THE CHICAGO CROSS ARM COMPANY, Chicago, Ill., capital stock $6,000, has been formed to manufacture, buy and sell cross arms and electrical machinery and specialties. The promoters are H. M. Angle, E. H. Willard and C. S. Marshall.

THE ZUCKER, LEVETT & LOEB COMPANY, New York, capital stock $100,000, has been incorporated by Alexander Levett, Charles Loeb, W. R. W. Hentz and Henry L. Haas, to manufacture electrical apparatus, platers' supplies and polishing material.

THE CO-OPERATIVE HEAT, LIGHT AND POWER COMPANY, Sioux Falls, S. D., capital stock $50,000, has been formed to manufacture and sell electricity, etc. J. H. Drake, Chicago, Ill.; W. C. Bolton, New York, and Jno. Sunback, Sioux Falls, S.D., are the interested parties.

THE OSBORNE SWITCH COMPANY, Newark, N. J., capital stock $100,000, has been formed to manufacture and sell machinery and appliances, etc. The promoters are L. A. Osborne, D. Demarest, H. C. Hines, J. P. Beatty, F. E. Osborne, R. D. Beatty and Wm. C. Morton, all of Newark.

THE KANSAS CITY ELECTRIC RAILWAY COMPANY, Kansas City, Kan., capital stock $1,000,000, has been incorporated by E. L. Euggrow, Ozone Park, N. Y.; F. B. Wilcox, Kansas City, Mo.; Louis Hummer, West Chester, Pa., and J. H. Parrott, R. A. Kope and P. F. Spickler, Kansas City, Kan.

THE UNITED ELECTRIC CORPORATION, Minneapolis, Minn., capital stock $10,000, has been formed to manufacture, buy and sell electrical apparatus for light, heat and power purposes and to construct and operate electric railways and power plants. The promoters are Samuel Grant, Faribault; George R. Kibbe, Paul W. Bossart and John H. Finney, St. Paul, Minn.

THE ELLICOTT ELECTRIC HEATING COMPANY, Buffalo, N. Y., capital stock $25,000, has been formed to manufacture apparatus for utilizing electricity for heating and power purposes. The directors are C. W. Pardee, John M. Schatcard, Daniel O'Day, Edwin T. Evans, G. Barrett Rich, George Urban, Jr.,

Jos. L. Hunsicker, Charles R. Huntley, John J. Albright, Edmund Hayes and Franklin D. Locke, Buffalo, N. Y.

Special Correspondence.

New York Notes.

Office of The Electrical World,
253 Broadway, New York, July 9, 1894.

KILLED BY ELECTRICITY.—Lawrence Arnold, a porter in a store at 777 Broadway, was killed on July 3 while oiling an electric fan, installed on an arc light circuit.

THE NASSAU ELECTRIC RAILROAD COMPANY, of Brooklyn, will erect a one-story brick power house on the wharf between Thirty-ninth and Fortieth streets, 106 by 150, with a corrugated iron roof.

MR. JOHN D. CRIMMINS is authority for the statement that a new trolley line will be built and be in operation on Jerome avenue in the next twelve months. The road will begin at MacComb's Dam Bridge, and run to Woodlawn.

THE WADDELL-ENTZ COMPANY, Bridgeport, Conn., has, through its receiver, applied to the court for permission to lease its works to E. P. Bullard, and a hearing on the application will be had at the Superior Court room, Bridgeport, on July 13.

MESSRS. HENRY HOLGATE and George. W. Hunt, of The Royal Electric Company, Montreal, Quebec, were callers at the offices of The Electrical World on Tuesday, July 3. They expressed themselves as being highly pleased with the many interesting features of New York and Brooklyn.

MR. F. A. MASON, formerly secretary and treasurer of the Interior Conduit & Insulation Co., like all who stray from the flock, is now desirous of returning to his first love, "electricity." Mr. Mason's experience will make him valuable to any electrical concern with which he may become identified.

MR. JAMES E. M'ELROY, head of the firm of James E. McElroy & Co., of Chicago, formerly of New York, died suddenly on Saturday, July 7. He will be succeeded by his brother, Mr. Robert L. McElroy, the resident partner in Chicago. There will be no other changes in the management of the corporation.

New England Notes.

Branch Office of The Electrical World,
Room 91, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., July 7, 1894.

THE BROWN ELECTRIC COMPANY, Boston, Mass., has just issued an illustrated catalogue covering its various electric light and railway supplies and general electrical specialties. The catalogue has evidently been carefully compiled, is neatly printed, and will be found to contain in "nutshell" form valuable information for the electrical trade.

THE HOLTZER-CABOT ELECTRIC COMPANY has issued a new edition of its descriptive catalogue of electrical house goods and supplies, which is in keeping with the current advance in catalogue work, the paper and press work being excellent and the cover tasteful in design and tint. A number of cuts are printed in colors on special paper, including views of a 300-number return call Keno annunciator, and a switchboard designed and built for the new Ames Building, Boston. The numerous cuts, as a rule, are excellent, as well as the descriptions and arrangement of matter.

AMONG THE RECENT REMOVALS of electrical firms in Boston, by no means the least important is that of Ziegler Bros., who now occupy the upper part of the Channing Building, in which is also located the establishment of The Pettingell-Andrews Company, the entrance to the office and factory being at 141 Franklin street, where they have a home of which they may justly feel proud. The office is spacious, with abundance of light, and affords splendid opportunities for the display of its various manufactures, and the manufacturing department is a model in every respect, embracing about 34,000 square feet, with abundance of light also, and plenty of room for the locating of its machinery. As is well known, the firm of Ziegler Bros. manufacture all kinds of electrical and mechanical apparatus. In its particular line of electrical specialties for schools, colleges and laboratories, the finest and most correct electrical and mechanical testing instruments, railroad signals, fire alarm and general protective apparatus, and, in fact, electrical and mechanical goods of all kinds, the firm enjoys deserved prominence. Its manufactures include from the smallest and most simple device to that of one and one-half tons weight, and it possesses all the facilities now for quick and satisfactory work. It is also kept very busy with repairing of all kinds, which is done promptly. Another important feature of the firm's business is the help it renders to inventors in the completion of new electrical ideas and models for patenting.

MR. FRED. A. SWAN, 180 Summer street, Boston, Mass., has recently completed the installation of an electric plant on Mr. W. H. Crane's yacht "The Senator," which for general design, neatness and workmanship certainly reflects great credit upon him. The plant installed consists of one 7½ h. p. vertical engine, connected directly to a 3½ kilowatt dynamo. This apparatus was constructed especially for Mr. Crane's yacht, and is very compact, the whole taking up only three feet in length. The switchboard is of polished black slate, mounted with nickel-plated knife switches and instruments, and is very compact and unique in design. There are 60 cups of storage battery capable of running forty 16 c. p. incandescent lights, which are to be used in case of accident or when it is not convenient to run the engine and dynamo. The cabin and pilot house are each fitted with four bull's eye nickel-plated fixtures, put in flush with the ceiling. All other parts of the boat are supplied with an abundance of light, there being a row of lights completely around the boat under the edge of the awning, and a three-light cluster in the centre of the awning over the entrance to the cabin. On the top of the pilot house there is mounted one 4,000 c. p. search light, capable of penetrating the darkness and bringing objects plainly to view at a distance of one mile. All of the electrical apparatus was designed by Mr. Swan; the dynamo was built by the Adams Electric Company, Worcester, Mass.; the engine by the Fore River Engine Company, Weymouth, Mass.; the switchboard by the Consolidated Electric Manufacturing Company, Boston; the storage battery by the Eastern Electric Light & Storage Battery Company, of Lowell, Mass.

Pittsburgh Notes.

Pittsburgh, July 7, 1894.

THE PENNSYLVANIA GENERAL ELECTRIC COMPANY has entered suit against the Citizens' Passenger Railway Company, of McKeesport, to recover $13,356.22. The amount is claimed to be due for electrical appliances sold and delivered to the defendant company. A similar suit has also been entered by the same plaintiff against the McKeesport Light Company for $39,118.47 for amount due on electrical appliances.

STREET RAILWAY STATISTICS.—The following figures give a very fair idea as to the condition of the electric railroads in this city, being receipts and expenses for one year:

	Receipts.	Expenses.
Central Traction Company	$183,721	$171,677
Citizens' Traction Company	711,577	387,628
Duquesne Traction Company	357,714	256,004
Pleasant Valley Traction Company	397,123	312,326
Manchester Traction Company	482,347	274,687
Pittsburgh Traction Company	422,560	365,784
Birmingham Traction Company	332,049	171,874
Second Avenue Traction Company	111,379	71,686
West End Traction Company	121,576	72,726

The number of passengers carried by these companies were: Central, 3,926,521; Citizens', 14,594,850; Duquesne, 6,889,970; Pleasant Valley, 7,942,480; Manchester, 9 646,946; Pittsburgh, 8,364,852; Birmingham, 6,875,378; Second Avenue, 2,362,962; West End, 2,528,177.

Canadian Notes.

Ottawa, July 7.

MONTREAL.—The Electric Surface Company of Canada (Limited) has taken an action for $10,000 damages against the Merchants' Electric & General Service Company (Limited). This is an outcome of the recent difficulties between the two companies.

MONTREAL.—The city has entered an action against the Montreal Street Railway Company for $26,354. The city claims this amount under the by-law which provides for the company paying half the cost of clearing snow during the Winter. The company's lawyers interpret the by-law differently.

MONTREAL.—The Montreal Street Railway Company is making extensive alterations to its buildings on Cheneville and Vitre streets. It is the company's intention to transfer the motor and repair shops from Hochelaga to this place when the changes are completed, which will probably be in about two months.

MONTREAL.—A number of Canadian and American capitalists met recently, and discussed at some length the advisability of organizing a new line of street cars which would be propelled by gas instead of electricity, as at present. The necessary plans will be shortly drawn and submitted to a committee for approval.

BELLEVILLE, ONT.—The City Council has granted a franchise to S. E. Legier & Sons to build, equip and run an electric street railway in Belleville; also for the privilege of erecting poles for stringing wires for supplying light, power and heat. The promotors are well known business men of this city, and the work will be begun at once.

ST. GEORGE, N. B.—Notice of application for the issuing of letters patent to incorporate "the Saint George Electric Light Company (Limited)" is published this week. The object of the company is to light St. George and adjoining districts with electricity. The applicants are Albert T. Dunn, T. H. Estabrooks, Fred. B. Dunn, A. P. Banhill and Wm. Bayard, M. D., all of Saint John.

OTTAWA, ONT.—The annual meeting of the Ottawa Electric Railway Company was held last week. The report declared a dividend of 4 per cent. for the half year, and gave the following figures: During the year there have been 2,797,281 passengers carried, against 2,395,504 during the previous year. This gives 8,900 for every working day. The receipts are given as $129,484.02, the expenses being $83,324.64. The cars traveled 759,433 miles. The company now operate 23 open cars, 31 closed, 3 postal, 2 closed and 2 open trailers, 5 sweepers and 53 electric equipments.

TORONTO.—A report was read at the last meeting of the Fire and Light Committee, showing that the cost of operating a city electric plant would be $103 per year per lamp for 1,300 lamps. Ald. Hubbard favored adopting Mr. Keating's report, which estimates the cost of operating the plant at $81.78 per lamp per year, but he was defeated. In the secretary's report four engineers are said to be necessary, at a total for salaries of $6,500 per year; seven inspectors, twenty trimmers, several foremen, clerks, storekeepers, machinists and other employees are reckoned as necessary, and altogether a staff large enough to run a plant sufficient to light a city six times the size of Toronto is provided for in Mr. McGowan's liberal estimates.

OTTAWA, ONT.—The bill now before the Dominion Parliament bringing electric lighting under Government inspection provides that an electric company before commencing to supply light to a purchaser must declare to the purchaser the constant pressure at which they propose to supply the energy at his terminals. No variation greater than 3 per cent. from this pressure to be permitted. The bill authorizes electric companies to inspect purchasers' premises in case of a dangerous connection. They may also discontinue a supply of electricity until the defect has been remedied. For every default in complying with any of these provisions a penalty not exceeding $20 for every day during which the default continues is provided. Any person fraudulently using or diverting any electricity is to be deemed guilty of theft. Officers of electric companies are authorized to enter consumers' premises to inspect or remove apparatus belonging to the companies. If the consumer so desires, the quantity of electricity he uses shall be ascertained by means of a meter. Inspectors appointed to carry out the provisions of the act are to certify to the correctness of all meters before they are put in operation.

English Notes.

(From our own Correspondent.)

London, June 27, 1894.

MULTIPLE-FILAMENT LAMPS.—Experiments with multiple-filament lamps having proved that there is practically no after-glow when the current is

switched off, the Admiralty have directed that they shall be adopted throughout the service for mast-head flashing lanterns.

MUNICIPAL STATIONS.—Two municipal electric light stations have been inaugurated during the past month. At one of these, viz., Portsmouth, Mr. Ferranti has introduced several novel features. His flywheel alternators are the first to be used in this country, and his alternate current rectifiers, which were used on the arc light circuits, have proved to be a great success. By means of these rectifiers Mr. Ferranti obtains a uni-directional constant current from an alternating constant potential, enabling the arcs to be run in series. The transformers at Portsmouth are of special design, being arranged so that by means of a key the windings may be altered for half or full load. The transformers are placed in pits below the foot pavements. At Burton, where the municipal station was inaugurated May 25, transformer pits are also used, and a man is sent round with a key to connect or disconnect them as the load rises or falls. This station is run in conjunction with the gas works, and uses the refuse coke breeze from the latter.

A MYSTERIOUS PHENOMENON.—The Portsmouth municipal electric lighting station was recently opened with the usual ceremony and feasting. After the feast the corporation and their guests proceeded to the central station, and were there subjected for some time to a somewhat trying after-dinner phenomenon. The station plant consists of two Ferranti flywheel alternators, and is illuminated by arcs, current for which is obtained from the alternators, but made pulsating and uni-directional by means of an appropriate commutator. The result was that the feasters witnessed the mysterious phenomenon of a steam engine driving ahead full speed, whilst the dynamo connected to it remained unconcernedly at rest. Worse, however, was to follow. The arcs were next run off another machine; the result was that the alternator, which had been previously remaining at rest, appeared to move first one way and then another, to rush suddenly round from left to right, pull up, and revolve slowly back from right to left. No ill consequences are reported.

AIR MOTORS FOR TELEGRAPH WORK.—At the last Royal Society Conversazione the Postmaster-General exhibited a Hughes telegraph and a Wheatstone transmitter, each of which was driven by a little Willmott air motor. The adoption of this means of driving these instruments results in an important gain. In the case of the Hughes apparatus, the air motor enables the 132 ponnds weight, the winding gear, and practically all the train of wheel work to be dispensed with. In the case of the Wheatstone high speed transmitter the 42 pound weight, which requires rewinding every few seconds, together with its complicated train of wheel work, is also got rid of. The motor for the Hughes instrument consists of a fan with radial vanes, the air being admitted at one end of a diameter, and following the fan round the circle; this motor is practically self-regulating, since any interference with the motion causes the air pressure to be pulled up behind. The Hughes apparatus, although invented by an Englishman, has not till now been used in this country, although its use has been widely extended on the continent. When, however, the submarine cables between England and France were taken over by the joint Governments, our French neighbors insisted that the line to Paris should be worked by the Hughes apparatus. The result has been that Prof. Hughes' invention has been forced upon the notice of the Post Office officials, and some of our busiest lines are now, or shortly will be, provided with Hughes apparatus, it being found that they can be worked out under conditions which entirely stop the working of other instruments.

WOODHOUSE & RAWSON UNITED (LIMITED).—The public examination of the directors, managers and auditors of Woodhouse & Rawson United, which went into litigation some time ago, has recently been taking place, considerable interest being shown in the proceedings by the general public. So far as the matter has gone up to the present, it would appear as if on the occasion of the numerous progeny of small Woodhouse & Rawson concerns being taken over by a single big concern, to which the public were invited to subscribe, transactions of a somewhat peculiar kind took place. As usual the new directors of the big concern (Woodhouse & Rawson United) made no inquiries until the public had been invited to, and had actually subscribed, though they then became so uneasy with regard to the whole matter that they promptly retired, leaving the new concern entirely in the hands of gentlemen interested in the old concerns. The good will of the old businesses was valued at £75,000 by the vender of them, and this valuation was accepted without demur by the purchasing company; one of the directors of the concern blandly admitting in court that if he had been purchasing property with his own money, and for himself, he should not tamely accept the vender's estimate of its value. The auditor appears to have certified the general correctness of various balance sheets, supplementing his certificates by reports which were of course suppressed. The law at present seems to be that an auditor is bound to address these sort of reports to the shareholders, but is not empowered to see that they get them. It is a great pity for the electrical industry that the firm of Woodhouse & Rawson should have obtained the reputation of being an electrical manufacturing firm, where their business was little more than that of company promoting.

News of the Week.

ELECTRIC LIGHT AND POWER.

HASTINGS, NEB.—The electric light plant will be improved. H. W. Miller is manager.

NASHVILLE, TENN.—The Cumberland Light and Power Company is preparing to enlarge its plant.

OSHKOSH, WIS.—Address the city clerk concerning the municipal electric light plant to be established.

SPRINGFIELD, O.—The Hess Storage Battery Company will establish a plant to construct the Hess battery.

MT. CARROLL, ILL.—Address the town clerk for information concerning an electric light plant to be established.

FT. DODGE, IA.—The City Council has granted a franchise for 21 years to S. T. Meservy for a street railway and electric lighting plant.

HILLSBORO, TEX.—The Hillsboro Investment and Electric Company intends erecting an electric plant, and is in the market for the apparatus.

NORWALK, CONN.—The Norwalk and South Norwalk Electric Light Company is about to be placed in the hands of a receiver, who has been applied for.

BRUNSWICK, MO.—The Franklin Electric Company, of Kansas City, has been awarded a contract to erect an electric light and water works plant at a cost of $10,600.

PENSACOLA, FLA.—The Citizens' Electric Light and Power Company has given out a contract for the erection of buildings, and is now in the market for the necessary apparatus.

AUGUSTA, GA.—C. V. Walker, Dyer Building, will give information in regard to free sites for manufacturing purposes. Power will be supplied at $5.50 per horse power per year.

JAMESTOWN, N. Y.—O. E. Jones asked that the Board of Public Works be empowered to employ an architect to assist in preparing plans and estimates for the electric light building.

JACKSONVILLE, FLA.—Commissioner King has presented plans and specifications for an electric light plant on which to base advertisements for bids at the meeting of the Board of Public Works.

BEL AIR, MD.—The Record Manufacturing Company will construct an electric light plant to light the town. The plant will be installed two miles from the village, and will be operated by water power.

HOPKINS, IA.—Hopkins has decided to have electric lights, and the council has passed an ordinance giving to Peter Milroy the exclusive franchise to maintain an electric light plant there for a term of twenty years.

BINGHAMTON, N. Y.—The State Hospital trustees held a special meeting, at which time Capitol Commissioner Perry's plans for an extension of the present electric lighting system to the adjoining farms were adopted, and Secretary Rogers was instructed to advertise for proposals for the construction of the same.

BAY CITY, MICH.—It was erroneously stated in these columns in the issue of June 30, that the Common Council had decided to expend $12,000 on its municipal plant. We are informed by the superintendent of the plant that this is a mistake, as the Common Council has concluded not to expend any money on the plant this year.

NIAGARA FALLS, N. Y.—At the last meeting of the Common Council the petitions of the Niagara Falls Hydraulic Power and Manufacturing Company and the Niagara Falls Power Company for franchises to erect poles and string wires for the transmission of power and heating, lighting, and manufacturing purposes by electricity were finally terminated by granting both of these companies the desired franchises under restrictions.

THE ELECTRIC RAILWAY.

HANOVER, MASS.—Hanover citizens are agitating the question of building a new electric railroad.

EAST MAUCH CHUNK, PA.—The citizens of East Mauch Chunk have decided on the extension of the electric railway.

CHESTER, PA.—The Crozier property, in South Chester, has been sold to a company that will erect an electrical engine works.

CHICOPEE, MASS.—The Chicopee Street Railway Company has petitioned for a franchise to construct a line from Holyoke to Springfield.

HUMMELSTOWN, PA.—The Citizens' Railway Company of Harrisburg has asked permission to build an electric railway through the borough.

JOPLIN, MO.—It is proposed to form a syndicate to buy the property of the Joplin Electric Railway and Motor Company and to extend the railway to Galena.

BALTIMORE, MD.—The Walbrook, Gwynn Oak and Powhattan Railroad Company has executed a mortgage for $100,000 to secure funds to build its electric road.

YOUNGSTOWN, O.—Sealed proposals will be received at the office of the Board of City Commissioners of Youngstown until July 14, for the construction and operation of a street railway line. Howard Edwards is city clerk.

BROCKTON, MASS.—A number of citizens, with Mr. J. C. Snow, the real estate man, as prime mover, have associated together as the West Side Street Railway Company to build and operate a new line of electric street railway in this city.

OMAHA, NEB.—L. W. Hardy, of Chicago, and T. J. Peachy, of Omaha, have invented an underground trolley system, consisting of a conductor in a trough, covered by a flexible rubber diaphragm, heads of rivets which are pressed against the conductor by a traveling device underneath the car, thus making contact for the motor current.

STROUDSBURG, N. Y.—The Delaware Valley Electric Railway Company, stock $1,000,000, all of which has been subscribed for by wealthy Philadelphia parties, will construct the electric road from Stroudsburg to Port Jervis. It is expected that a portion of the road between Port Jervis and Milford and Bushkill and Stroudsburg will be completed by October 1 of the present year, and between Milford and Bushkill on or before June 1, 1895.

WHITE PLAINS, N. Y.—The Board of Trustees has finally adopted the Electric Railroad Committee's report. The companies desiring the franchises to construct a railroad from Mamaroneck to White Plains and from Elmsford to White Plains must deposit $5,000, to be forfeited if the roads are not built within a year, and must give a $20,000 bond for fifteen years, as a guarantee to fulfil every requirement exacted by the village authorities. The vote granting franchises to the New York, Elmsford & White Plains & Mamaroneck Railway Company were reconsidered.

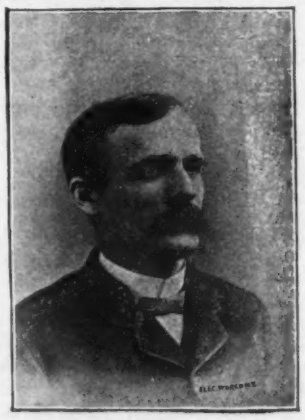
PORT JERVIS, N. Y.—The Delaware Valley Railway Company, of Pennsylvania, capital $1,000,000, has been chartered. The treasurer, Simon Friedberger, is also treasurer of the Wakefield Electrical Engineering Company, of Philadelphia; Mr. Ellicott Fisher is president, and Mr. Michael W. O'Boyle, secretary. Among other incorporators are G. H. Lang, Joseph S. Potsdamer and Louis Lang. This company will construct and operate forty miles of road, from Port Jervis, N. Y., to Stroudsburg. A large force of men will equip the work at both ends of the line at once, and at least twenty-five miles will be built before the end of the year.

POTTSVILLE, PA.—The Car Equipment Company of Philadelphia has purchased the controlling interest of the Schuylkill Electric Railway Company, of Pottsville, Pa., and intends to extend the line about twenty-five miles in and around Pottsville, connecting St. Clair, Middleport, Tremont, Schuylkill Haven and other towns near by. Jesse Newlin and Robert Alliston have retired from the old Board of Directors, and W. A. Barritt, Jr., and Charles H. Barritt, president and treasurer respectively of the Car Equipment Company of Philadelphia

have been elected to fill the vacancies. J. B. Stuart, of Philadelphia, has been appointed electrician and general superintendent, and his success in the construction of the Pottstown, Camden and Gloucester roads will assure an efficient system for the roads at Pottsville. The Schuylkill Electric Railway Company has a capital stock of $150,000, which was raised by popular subscription from the residents of Pottsville and fully paid in. The road was originally built out of the capital stock, and the improvements or betterments from time to time were contracted for out of an issue of bonds. The road has a bond indebtedness of $95,000. The Schuylkill Electric Railway proper consists of ten miles of road with eighteen car equipments, about half of which are new and the remainder consisting of Short apparatus, which will be no doubt replaced in the very near future with a more modern equipment. New feeder wire will be put in on the entire system to supply sufficient and additional power for the extra car equipment that will be added, and a new car barn will be built at Palo Alto. The entire system will be overhauled and will be put in a first-class position as soon as possible.

PERSONAL NOTES.

TWO NAMES well known in electrical circles, not only in Boston, but throughout New England and the whole country as well, are those of A. Arthur Ziegler and J. Oscar Ziegler, members of the firm of Ziegler Bros., of Boston, Mass., manufacturers and dealers in electrical specialties for schools, colleges and laboratories. Mr. A. Arthur Ziegler is now about 31 years of age, was born in Switzerland, and was about 7 years of age when his parents came to this country. He was given a good public school education, and at the early age of 16, in the year 1879, he commenced his electrical apprenticeship with the old establishment of Charles Williams, Jr., of Boston, where his brother, J. Oscar Ziegler, was foreman of the instrument and experimental department. This was in the early days of electric work, when the telegraph was supreme and the telephone just entering. He remained with Charles Williams and the Western Electric Company, which succeeded him, until just previous to the removal of the plant to New York, in all about six years, during which time, through close application and well-directed energy, he acquired a thorough knowledge of the business. Desiring to familiarize himself with large machinery, he afterwards identified himself with the South Boston Iron Works. From thence he became associated with the Schaeffer Electric Manufacturing Company, afterwards known as the Germania Electric Company, leaving this company to connect himself with A. L. Russell, of Boston, who succeeded to a portion of the business of Charles Williams, with whom he remained for a number of years. He was also identified for a short period with the Holtzer-Cabot Electric Company. On May 1, 1889, he organized the present firm of Ziegler Bros., composed of himself and his brother, J. Oscar. Mr. J. Oscar Ziegler was also born in Switzerland, and is now about 43 years of age. He was given an excellent school and college education in Switzerland, and at the age of 17 was apprenticed to A. Saurer & Sons, in the city of Arbon, on Lake Constance, who are large manufacturers of steam engines and silk embroidery machinery. He was about 20 years of age when his parents located in this country, and began his career here with the American Safe Company, confining himself particularly to the intricate mechanism of "time locks." In 1873 he associated himself with Charles Williams, Jr., of Boston, and was closely identified through this connection with Prof. Bell in all his early experimental work upon the telephone. He was also in these early years brought into intimate contact with Moses G. Farmer. Previous to the organization of the firm of Ziegler Bros., like his brother, he was associated with A. L. Russell and the Holtzer-Cabot Electric Company.



MISCELLANEOUS NOTES.

JUDGE RICH'S DECISION in the case of the Buckeye Company, of Cleveland O., was sustained by Judge Dallas in an opinion handed down from the bench of the United States Circuit Court at Lancaster, Pa.

THE VIADUCT MANUFACTURING COMPANY, Baltimore, Md., lost its extensive electric manufacturing plant by fire on June 30. During a storm the buildings were twice struck by lightning, the second stroke shattering the machine shop and starting the fire. The damage is estimated at $50,000, on which there is $35,000 insurance. About 125 workmen are thrown out of employment, but temporary quarters will be occupied at once, as the company has many orders ahead. President Davis and his associates have our sympathy, but their well-known business enterprise will doubtless meet with a stimulus from this misfortune, which will more than counterbalance it.

Trade and Industrial Notes.

WILMINGTON, DEL.—Worrell & Ryon, electrical engineers, have dissolved partnership.

J. JONES & SON, 67 Cortlandt street, New York, report that they have just closed a contract with one of the large motor companies to furnish them with a year's supply of their Anti-Thunderbolt paper. They will also in the near future keep in stock a complete supply of the Kester lamps, made by the F. B. Little Company, of Buffalo.

THE J.T. CARPENTER TAP & DIE COMPANY, Pawtucket, R. I., has issued a new catalogue and price list containing illustrations, descriptions of its taps, dies, tap wrenches and other goods manufactured by it.

THE HARRISON INTERNATIONAL TELEPHONE CONSTRUCTION COMPANY will move its general offices to the Chamber of Commerce Building, Chicago, this week, the general offices of The Harrison International Telephone Company remaining here. This change is made imperative from the great growth of the Western business of this flourishing company.

THE ST. LOUIS RAILWAY COMPANY, of St. Louis, Mo., have placed the order for their new car barn with the Berlin Iron Bridge Company, of East Berlin, Conn. The building will be 64 feet in width, and 185 feet in length, with brick walls, the roof being of iron covered with The Berlin Iron Bridge Company's patent anti-condensation corrugated iron roof covering. It is the intention of the railroad company to make this station absolutely fireproof and thereby save insurance.

THE ELECTRIC APPLIANCE COMPANY, Chicago, states that it started into the Summer season without any special arrangement on a direct current fan motor, intending to devote all of its energy to the sale of the Meston alternating current outfit. A heavy demand set in, however, for a direct current fan motor, and it has succeeded in getting hold of such a desirable article in the Acme direct current fan motor that it is pushing them extensively, and claims to have the best direct current fan motor introduced this season.

THE STANDARD ELECTRIC TIME COMPANY, on and after June 20, 1894, will have its main office and factory located at 23 Jefferson street, Waterbury, Conn., where all communications, express and freight, should be sent, instead of to New Haven, as heretofore. The company will here have greatly increased facilities for the manufacture of its electric time system, self-winding clocks, electric tower clocks, and electric dial system, all of which have established an enviable reputation for simplicity and reliability.

THE MASON TELEPHONE COMPANY is the name of a new concern which has just been organized in Richmond, Va., to manufacture telephones. Messrs. C. T. and W. A. Mason are the inventors of the telephone, and have perfected an exchange system that has been introduced with success in several cities. The advantages claimed for the new system are non-infringement, simplicity of construction and superiority of transmission of sound. A number of the most prominent men in Richmond are interested in the company.

THE WAKEFIELD ELECTRICAL ENGINEERING COMPANY, No. 731 Reading Terminal, Philadelphia, Pa., is very busy in railway work: it is just finishing a seven mile extension from Harleigh to Freeland, Pa., for the Lehigh Traction Company, and have started work on an eight-mile road from Tamaqua, through Lansford, to Summit Hill, Pa., and has also closed contracts for a 40-mile road from Port Jervis, N. Y., to Stroudsburg, Pa. Mr. Charles E. Hague, formerly with the Pennsylvania General Electric Company, is general manager of the Wakefield Electric Engineering Company.

QUEEN & CO., INCORPORATED, of Philadelphia, have a new form of central station voltmeter, the dial of which is arranged in the shape of a semicircle 14 inches across, the scale covering 180 degrees. Thus it will be evident that the divisions are far apart so that small fractions of a volt can be easily read at some distance. An adjustable index, which can be set at any desired point, is also supplied. This voltmeter can be left in circuit all day long without injury, and is described in circular No. 535, which the makers will mail upon request. They also have a full line of switch-board instruments for isolated plants.

THE E. G. BERNARD CO., 43 Fourth street, Troy, N. Y., have bought out the stock of material, completed and partly completed machines and special tools of the Adams Electrical Company, of Worcester, and will continue the manufacture of the Adams dynamos and motors, making a specialty of sizes up to 10 k.w. capacity, both high and low speed. The above stock of completed and partly completed machines will enable the E. G. Bernard Co. to continue the business at once. Mr. A. D. Adams, late manager of Adams Electrical Company, will be connected with the E. G. Bernard Co. in the manufacture and sale of the machines.

BARTLETT & CO., engravers and printers, 21 Rose street, have issued a beautiful pamphlet entitled "A Modern Triumvirate," which describes in an agreeable style the different departments of their business. The exceeding fine character of the work done by this firm is well illustrated in this brochure, not only in engraving but in press work and binding. The embossed cover and title page are works of art in every sense, and the whole production is one that could scarcely be equalled outside of France, though even there we know of no firm that can rival Bartlett & Co. in commercial catalogue work. Though the Germans have recently issued some very elaborate commercial catalogues, they lack the artistic element so predominant in the work of this firm.

THE ELECTRIC STORAGE BATTERY COMPANY, Drexel Building, Philadelphia, has issued a new edition of its catalogue of the chloride accumulator, which contains considerable new matter, including some particulars of the Paris-St. Denis storage battery tramway, an account of which appeared in our columns several months ago. Five types of cells are now listed, ranging in capacity from 12½ to 5,000 ampere hours. Types C and D have been added, the plates of these being 4x4 inches and 6x6 inches respectively. An appendix contains a number of flattering testimonials to the merits of the chloride accumulator, among the writers of which are Professors Houston, Chandler, Callender and Barker, A. E. Kennelly, the North American Phonograph Company, the American Graphophone Company, the electrical engineer of the Edison Kinetoscope, and users of the battery for isolated and central station lighting purposes, and some others.

THE CHAS. E. GREGORY COMPANY, Chicago, Ill., report the following sales for June: Fifty light D 12 Thomson-Houston arc dynamo, to P. Norcross, Janesville, Wis.; two 30 and one 20 light Sperry arc dynamo, to B. Marks, Chicago; one 6-light Sperry arc dynamo, to Jas. I. Ayer, New York, N. Y.; one 3-light Excelsior arc, to J. P. Karr, Reynolds, Ind.; one 500-light 1,000-volt Thomson-Houston alternator, to P. Milroy, Hopkinton, Ia.; two 180 ampere Westinghouse generators, to International & Wells Packing Company; one 180 ampere Westinghouse generator, to W. T. Osborne & Co., Kansas City, Mo.; one 210-light Edison generator, to Geo. B. Weiss & Son, Chicago; one

25-h. p. direct-connected Westinghouse motor, to O. H. Parker, Anniston, Ala.; three 3-h. p. and one 5-h. p. Westinghouse motors, to Andrews & Johnson, Chicago; one 2-h. p. Sperry series generator, to John Raber, Chicago; one 3 kw., 500-volt Edison motor, to M. Schu, Aurora, Ill.; one 3 kw. 220-volt Edison motor, to Chicago Braid and Embroidery Company; one 1 h. p. Crocker-Wheeler motor, to Four Lakes L. & P. Company, Madison, Wis.; one 1 h. p. C. & C. motor, to A. L. Daniels, Marion, Ia.; one 1-h. p. Jenney motor, to E. J. Davis, Aurora, Ill.; one 1-h. p. Rockford motor, to George Wolfe, Chicago; one 1-h. p. Detroit motor, to Baltimore Cafe, Chicago; one 1-h. p. Crocker-Wheeler, to Lyon & Healy, Chicago; one 1-h. p. Edison motor, to Goltz & Sinclair, Milwaukee, Wis.; 14 Edison arc lamps, to W. T. Osborn & Co., Kansas City, Mo.; 6 Knowles D. C. arc lamps, to Kuh, Nathan & Fischer, Chicago; 15 Edison arc lamps, to Max Eichberg, Chicago; 6 Edison arc lamps, to B. F. Harris, Jr., Champaign, Ill.; and a total sale of 47 fan motors of various sizes and inds.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MANUFACTURING COMPANY, 2140 DeKalb street, St. Louis, Mo.

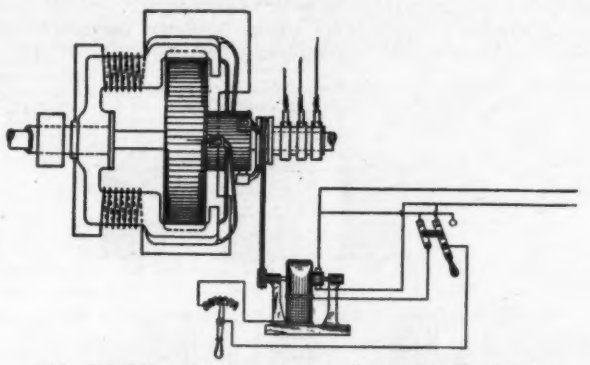
ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

UNITED STATES PATENTS ISSUED JULY 3, 1894.

(In charge of Wm. A. Rosenbaum, 177 Times Building, New York.)

522,189. ELECTRIC RAILWAY TRUCK; F. O. Blackwell, Lynn, Mass. Application filed May 1, 1891. The combination with the driving axle of a railway truck and motor shaft connected thereto through flexible coupling and gearing, of a gear wheel casing having a portion flexibly mounted to follow the movement of the motor shaft.

522,209. ORGAN; R. Hope-Jones, Birkenhead, England. Application filed September 18, 1891. The combination of a portable console frame, a key frame adjustable as a whole thereon, and a separable portable pedal frame.



NO. 522,241.—ALTERNATING CURRENT DYNAMO ELECTRIC MACHINE.

522,231. AUXILIARY FIRE ALARM SIGNAL SYSTEM; J. Sachs, New York, N. Y. Application filed November 8, 1893. This comprises an alarm box, an auxiliary releasing circuit, a working generator, an automatic switch for throwing said generator into circuit, a tell tale signal, and a circuit breaker in the circuit, the generator being operated by the tell-tale mechanism.

522,232. ELECTRIC SAFETY FUSE; J. Sachs, New York, N. Y. Application filed April 10, 1893. This comprises a strip melted by an excess of current, in combination with a material surrounding the strip, such as silicic acid, that will combine with the metal and form a non-conductor.

522,233. ELECTRIC ARC LAMP; A. Schweitzer, Alleghany, Pa. Application filed December 28, 1893. The combination with oppositely extending arms for supporting the carbons, one of the arms having a hinged joint, of means for adjusting the hinged section laterally to align and bring the carbon points in coincidental relation.

522,241. ALTERNATING CURRENT DYNAMO ELECTRIC MACHINE; Elihu Thomson, Swampscott, Mass. Application filed October 21, 1893. The method of varying the periodicity of an electric current, which consists in successively and continuously changing the points of line connection in either direction around a rotating commutator independently of its own rotation. (See illustration.)

522,242. PROCESS OF MANUFACTURING INSULATING MATERIAL; A. F. Tinnerholm and C. F. Paterson, Schenectady, N. Y. Application filed July 31, 1889. A sheet composed of scales or pieces of mica, and made up by adding less than 10 per cent. of powdered gum or resin between the scales.

522,274. DYNAMO ELECTRIC MACHINE; C. E. Scribner, Chicago, Ill. Application filed June 1, 1889. The two pole pieces of a dynamo, each provided with two cores, each pole being on opposite sides thereof, and the coils thereof being included in a shunt around the translating devices which are being supplied with current from the machine, in combination with a third core for each pole piece connected with a projecting portion of each pole piece, the extra pole pieces being on opposite sides of the armature and in the same plane, and with the other cores in a plane at right angles to the axis of the rotation of the armature, the extra pole pieces being provided with coils included in the main circuit.

522,275. REGULATOR FOR DYNAMO ELECTRIC MACHINES; C. E. Scribner, Chicago, Ill. Application filed October 14, 1889. This comprises a brush carrier constantly impelled in one direction by a constant force, and an intermittently acting motor adapted to impel it in the opposite direction, the frequency of the operation depending upon the strength of the main current.

522,276. ELECTRIC ARC LAMP; A. W. Smith, San Francisco, Cal. Application filed April 2, 1894. This comprises a sliding frame, a solenoid coil, a core, bell cranks fulcrumed upon yielding springs, gripping shoes and links connecting the bell cranks with the core.

522,277. WINDOW SPRING FOR BURGLAR ALARMS; J. Steiner, Brooklyn, N. Y. Application filed November 4, 1893. A window spring provided with a lever and a circuit spring carrying upon one side of it an insulating disc, and a contact point to make connection with a base, and upon its other side a distance post to hold it at a fixed distance from the lever.

522,286. DYNAMO ELECTRIC MACHINE OR MOTOR; Charles S. Bradley, Avon, N. Y. Application filed October 29, 1893. A dynamo electric machine or motor having its field magnet circuit in series relation to the armature circuit and provided with an electrical connection at a point intermediate of the terminals with the frame. (See illustration.)

522,294. ELECTRIC ARC LAMP; E. and F. W. Heymann, Boston, Mass. Application filed April 14, 1893. A carbon for arc lamps consisting of a block provided with grooves alternately arranged on its opposite faces.

522,302. SELF LOCKING CLEAT FOR ELECTRIC WIRES; E. Nashold, Chicago, Ill. Application filed February 23, 1894. This consists of a block having recesses adjacent to its support and grooves extending obliquely across the cleat, and with a vertical bend therein, and terminating in flaring openings.

522,327. ELECTRIC ARC LAMP; J. F. Kester, Buffalo, N. Y. Application filed November 23, 1893. The combination with the frame and feed mechanism, of a magnet controlling the movement of the frame, rock lever having one arm connected with the armature of the magnet, and a block adjustably secured to the other arm of the lever and connected with the carrying frame.

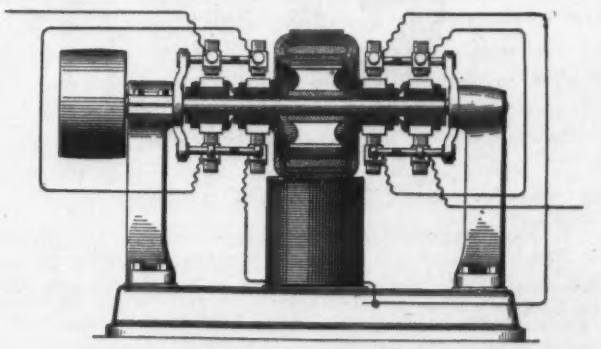
522,332. ELECTRIC SWITCH; John Van Vleck, New York, N. Y. Application filed May 28, 1894. In combination with a three wire distributing system, three pairs of contact fingers respectively connected to the terminals of each conductor, a rotary support, and three circuit closing plates on the periphery thereof; with each of said plates each pair of fingers makes contact, the fingers connected with the neutral conductor of the system being of such length relatively to the fingers connected with the other two conductors as that when said contact plates are moved by the rotation of said support into contact with said fingers, circuit shall be closed through said neutral conductor before it is closed through the remaining conductors.

522,344. ALTERNATING CURRENT MOTOR; John F. Kelly, Pittsfield, Mass. Application filed February 6, 1894. An alternating current motor consisting of an inducing system having, when energized by an alternating current, a symmetrical single phase alternating current magnetic field in combination with a closed symmetrical induced system, the two systems being relatively movable.

522,346. AUTOMATIC FIRE ALARM; C. A. Mann, Buffalo, N. Y. Application filed March 16, 1894. The combination of a base and terminals of a switch spring adapted to connect the contacts on the terminals, a supporting rod in front of the terminals, and a laterally sliding fusion link mounted on the rod and engaging with the switch spring.

522,349. RAIL JOINT AND BOND FOR ELECTRIC RAILWAYS; J. Meyer, New York, N. Y. Application filed October 21, 1893. This comprises a base plate, angle plates connected to the rail ends and to flanges on the base plate, a bond connecting the base of the rail ends, and a filling of asphalt run into the trough of the base plate.

522,356. ALTERNATING CURRENT MOTOR; William Stanley, Jr., Pittsfield, Mass. Application filed April 2, 1894. An alternating current motor, consisting of a field magnet, the energizing coils of which do not coincide as to their average centre with the centre of the figure of their pole piece and the field of which, when energized, is of single or uniform phase, in combination with an induced system symmetrical about an axis, around which one of the members is free to rotate. (See illustration.)



NO. 522,286.—DYNAMO OR MOTOR.

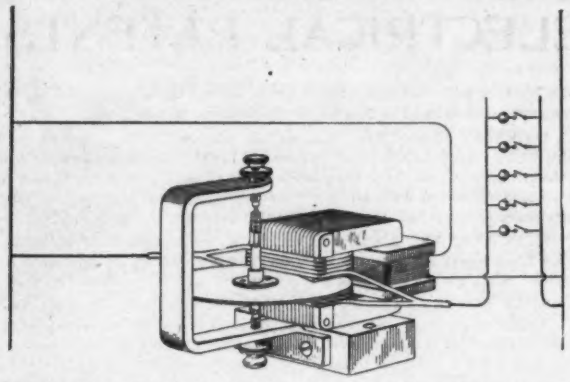
522,362. SUSPENSION CLIP FOR TROLLEY WIRES; W. F. D. Crane, East Orange, N. J. Application filed March 10, 1894. The means for applying a trolley wire clip having opposed hooks, consisting of a handle with projections adapted to engage the upper side of the wire and the under side of the clip.

522,370. DISTRIBUTING BOARD FOR ELECTRIC CIRCUITS; Rienhold Herman, Crafton, Pa. Application filed December 14, 1893. A terminal for a

distributing board having in combination a socket portion provided with a shoulder or flange, a threaded stem, a holding nut and a lock nut fitting on the threaded stem.

522,374. ELECTRIC RAILWAY SUPPLY CIRCUIT; Rudolph M. Hunter, Philadelphia, Pa. Application filed May 8, 1894. In an electric railway the combination of two railway tracks, feeding conductors connecting respectively with the conductor of similar polarity of the two railways, separate generators having their similar poles respectively connected with the two supply conductors, and a common return circuit connecting conductors of other polarity in parallel and in electrical connection with the other terminals of the said generators.

522,388. ELECTRIC RAILWAY SWITCH AND TROLLEY; Frederick S. Perrin, Lynn, Mass. Application filed March 12, 1892. The combination with the trolley wheel of side arms whose upper ends are arranged to extend



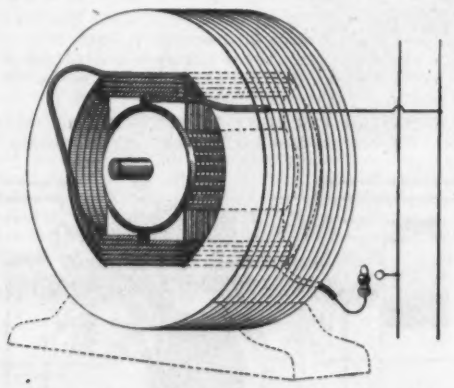
No. 522,345.—PRODUCTION OF CONTINUOUS MOTION BY ALTERNATING CURRENTS.

over the trolley wire, and are movable toward and from each other, and rollers on the ends of said arms, the axes of said rollers being inclined.

522,404. TELEPHONE TRANSMITTER; William R. Cole, Detroit, Mich. Application filed April 30, 1894. The combination with the transmitting diaphragm of a curved spring bar arranged across the diaphragm and carrying one of the electrodes centrally in contact with the diaphragm, the inward movement of the diaphragm tending to straighten the bar, and a bell crank lever against one arm of which one end of the spring bar bears, and a spring bar forming the long arm of the bell crank, and carrying the other electrode bearing against the electrode on the spring bar.

522,428. INSULATOR; Romaine Mace, New York, N. Y. Application filed May 3,1894. A tubular insulator inserted in an opening in a timber or support and provided with a lug or extension in combination with means for securing said lug or extension to the timber or support.

522,431. ELECTRIC ALARM SIGNAL FOR RAILWAY CROSSINGS; James J. Ross, Detroit, Mich. Application filed April 17, 1894. In an electric railway signal, the combination of two normally closed rail circuits at opposite sides of a crossing, each including a track relay, adapted to be short circuited by the train while passing over the rails of an electric alarm circuit having two branches containing normally open breaks, controlled by the track relays, a controlling relay provided with a main and shunt circuit,



No. 522,356.—ALTERNATING CURRENT MOTOR.

two normally open breaks in branches of the shunt circuit controlled by the track relays, a normally open break in the shunt circuit controlled by the controlling relay, and a normally closed break in the alarm circuit controlled by the controlling relay.

522,440. CONDUIT ELECTRIC RAILWAY; John H. Tyrell, New York, N. Y. Application filed January 23, 1894. The combination with the car of the trolley arm suspended beneath it, a support mounted on the lower end of the arm and adapted to swing relatively thereto and transversely of the car, and a trolley on the said support.

522,454. MACHINE FOR TEACHING TELEGRAPHY; Thomas Mortimer Crepar, Clare, Mich. Application filed March 20, 1894. The combination with the case, the pulleys therein, the circuit breaker and the belt carried by the pulleys and adapted to actuate the circuit breaker, of the hanger having pulleys to carry the outer end of the belt, and the longitudinally adjustable rails supporting the hanger and extending into the case.

522,460. ELECTRIC RAILWAY CONDUIT; Albert T. Fay, Minneapolis, Minn. Application filed April 15, 1894. In an electric railway conduit, the combination with the cross ties and the rails thereon, of the stringers resting upon the tops of said cross ties, surface plates secured upon the tops of said stringers, a slot being left between the inner edges of said plates, a strip of insulating material arranged parallel with said stringers and on the ties, an electric conductor on the top of said strip and the lower part of the conduit, openings being provided between the ties and leading into said lower part.

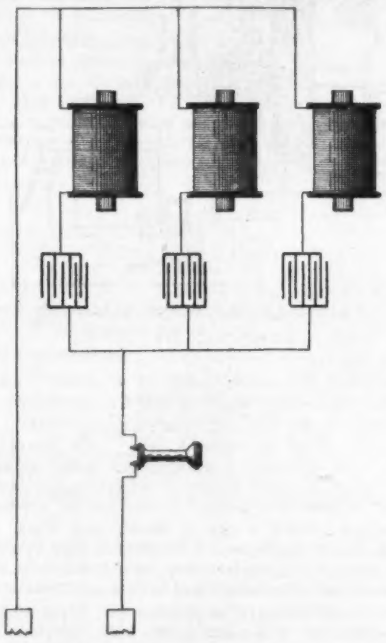
522,461. CONDUIT FOR TROLLEY ARMS; Albert T. Fay, Minneapolis, Minn. Application filed July 26, 1892. The combination with a car, of the track for the same, an underground conduit provided with a surface slot, a trolley arm having the thin flattened portion and the yoke to receive the trolley wheel, and a breakable section of weaker metal arranged between the top of the conduit and the car.

522,473. TORPEDO MACHINE OR APPARATUS FOR RAILWAY SIGNALING; Jacob W. Lattig, Easton, Pa. Application filed February 15, 1894. In combination, the pivoted track lever, the upright rod pinned to said lever, the vibratory armature lever carried by the upright rod, the toe or projection against which said vibratory arm acts, the rock shaft on which said toe is mounted, a hammer mounted upon the same shaft and an electromagnet whereby said armature lever may be influenced.

522,479. ELECTRODE FOR SECONDARY BATTERIES; William Morrison, Des Moines, Ia. Application filed April 25, 1894. An electrode for secondary batteries, the body of which is formed by a band composed of a plurality of lead ribbons in close contact throughout, said band being folded and refolded flatwise of the ribbons, and having spaces within the folds to provide for the thickening of the ribbons by the expansion of the lead.

522,500. TELEGRAPH REPEATER; Aldred Dee Pinckney Weaver, Jackson, Miss. Application filed December 26, 1893. A telegraphic repeater, comprising a sounder consisting of the combination of an armature lever, two independent sets of electromagnets, both arranged upon the same side of the fulcrum of said armature lever and both in local circuits, a frame, and a spring contact combined with and interposed between the armature lever and frame, and the circuits and batteries arranged.

522,506. ELECTRIC CONVERTER; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed November 14, 1893. In an



No. 522,564.—MULTIPLE TELEPHONY.

electric transformer, the combination of two connected standards composed of magnetic material and provided with eyes at their upper ends, a core supported at its opposite ends in said eyes, and primary and secondary coils on said core.

522,507. ELECTRIC CONVERTER; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass. Application filed November 29, 1892. An electric transformer having a secondary coil composed of a series of incomplete rings, and a movable brush for completing the circuit of any one or more of said rings.

522,527. ELECTRIC AUTOMATIC CIRCUIT BREAKER; C. W. Larson, Lynn, Mass. Application filed October 17, 1893. This comprises fixed contacts, a sliding rod carrying a bridging contact, a spring, an electromagnet arranged in circuit, a yielding armature carrying a catch, a toggle lever fixed at one end and connected at its other end to the sliding rod, and a hook carried by the toggle lever and adapted to engage the catch.

522,528. ELECTRIC TORPEDO APPARATUS AND SYSTEM FOR RAILWAY SIGNALING; J. W. Lattig, Easton, Pa. Application filed February 27, 1894. This comprises a track circuit and relay, a torpedo apparatus having a break in its exploding mechanism, a magnet controlling the same, and a circuit including the torpedo magnet, a branch circuit, a torpedo track section and connections whereby, by and during the passage of a train over the torpedo track section the branch circuit is put in condition to cause the torpedo magnet to maintain or restore the break in the torpedo exploding mechanism.

522,559. GALVANIC BATTERY; F. Fullner, Chicago, Ill. Application filed August 28, 1893. This consists of a zinc element in a solution of potash, the proportions being substantially one pound of potash to seven quarts of water, and a carbon element in a porous cup containing a solution of sulphuric acid and nitrate of soda, the proportions being substantially four parts of sulphuric acid, three parts of water, and one part of nitrate of soda.

522,564. MULTIPLE TELEPHONY; Maurice Hutin and Maurice Leblanc, Paris, France. Application filed June 1, 1894. The improvement in the art of telephony, which consists in transmitting vocal or other sounds by generating electrical undulations similar in form to the sound waves, and selecting therefrom and charging a line with components of these electrical undulations. (See illustration.)